BELL TELEPHONE QUARTERLY

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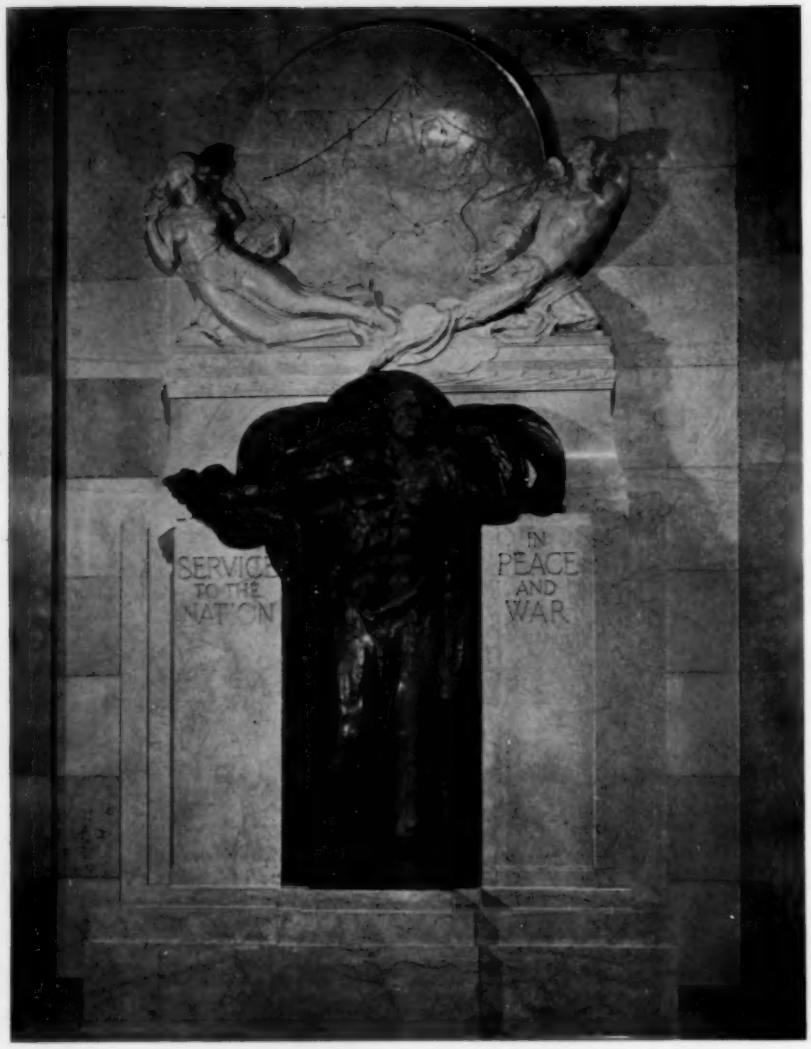
AMERICAN TELEPHONE & TELEGRAPH CO.
NEW YORK



"SERVICE TO THE NATION IN PEACE AND WAR," sculpture in bronze and marble by Chester Beach recently installed in the headquarters building of the American Telephone and Telegraph Company in a place which was designed for this purpose when the building was erected.

BELL TELEPHONE QUARTERLY

A MEDIUM OF SUGGESTION
AND A RECORD OF PROGRESS

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1928 Stock Offer of the American Telephone and Telegraph Company

IN order to provide the Bell System with funds needed for new plant construction, the American Telephone and Telegraph Company offered its stockholders of June 1, 1928, additional stock at par, $100, in the proportion of one new share for each six shares then held. The terms of this offer were the same as for the preceding offer in 1926, except that the rate of interest allowed on subscription payments during the installment period was five percent instead of six. The subscription privilege expired on August 1, 1928.

Largest Bell System Financing

The par value of this offer was $185,863,000, exceeding by some $30,000,000 the amount of its predecessor. It constituted the largest piece of financing ever undertaken by the Bell System. Its size, however, was not large in relation to the total capital obligations of

the Bell System already outstanding, nor did it represent a large average investment per stockholder.

Over 430,000 stockholders were entitled to subscribe under the offer, a number greater by 250,000 than the next largest stock list of an American corporation. If these stockholders and their families had been living together in one community, they would have formed a city larger than Detroit. One can picture the difficulties of making a stock offer in a city as large as Detroit involving one member of every family living there, not alone its bankers and its business men, but every element in its population as well, including many of its sick, aged and infirm. Even with this concentration of stockholders within the confines of one city, where they could be quickly reached by mail, by telephone, or by personal visit, it would have been practically impossible to make them all understand the offer and utilize their rights before its close.

265,000 Subscriptions Received

The 265,000 subscriptions to this issue were for more than 99½ percent of the stock. This result, which bettered the record of the previous issue, did not come by accident; it was due to the local facilities provided to help stockholders as heretofore and to additional efforts made to reach those who were thought most likely to need assistance.

Assistance to Stockholders

It was explained to stockholders in the announcement circular of May 16 covering the offer that information and assistance could be obtained from local Bell Telephone business offices; and to make this service effective provision was again made by the Bell Telephone Securities Company so that most of these offices could accept small orders to buy and sell rights and also receive subscriptions for transmittal to the American Company. Along with the subscription

warrants mailed later, there were sent a brief letter of explanation from the President of the Bell Telephone Securities Company, a series of questions and answers about the offer and an order blank for convenient use in requesting the purchase or sale of rights. Then with the July dividend checks a final notice was enclosed reminding stockholders once more of the expiration date.

In 1926, when similar measures were taken, over 20,000 stockholders allowed their rights to lapse. For the most part they were owners of fractional warrants only, but as a result 1 percent of the issue remained unsubscribed. It appeared that such of these who were still stockholders would be the ones that could be singled out as most likely to suffer financial loss through nonuse of their rights. A list of them contained the names of some 15,000 people, distributed throughout the country, and under date of July 11 they were all mailed individually addressed letters urging them not to sacrifice their rights.

In a desire to offer personal assistance to their patrons wherever it seemed most needed, Associated Companies secured the names and addresses of these people living in their states and tried to reach them before the close of the subscription period. Employees doing this work reported that about half the interviews could be concluded satisfactorily by telephone. For others the telephone call was followed by a personal interview to insure complete understanding of the value of the rights or in some cases the motive in bringing the matter to their attention. Unfortunately, some stockholders for various reasons could not be reached in time.

It was chiefly by means of this follow-up work, special letters from the American Company and personal calls from Associated Companies, that the percentage of unused rights was cut in two as compared with the 1926 record. Rights worth many thousands of dollars were thus exercised or sold for others to exercise which

would have become valueless if allowed to lapse. In most cases the money saved for stockholders was money they could ill afford to lose. For instance, one stockholder was visited who was blind and partially deaf and whose wife was an invalid. They were in needy circumstances and were ignorant of the value of the warrants they had thrown away. The rights were found, however, in a pile of old papers and a check for the proceeds was later delivered. In another typical case, a poor woman holding 4 shares of stock said that she had received a letter from the American Company wanting to know if she cared to buy any more stock. Having no money to spare she said she did not answer the letter and had thrown all the papers out. They were finally located in a waste barrel and she received a check for $46.70 as the proceeds.

Most of those who were approached expressed surprise and gratitude at the interest which the Bell System was taking in their financial welfare; they had not believed a large corporation would go to the trouble of communicating with small stockholders to assist them in this manner. It was discovered that at least 4,000 stockholders would doubtless have let their rights lapse, even after receiving the special letters above referred to and other communications, if they had not been interviewed by employees.

Transactions Through Associated Companies

Counting all contacts which Associated Companies had with stockholders in the purchase and sale of rights and the receipt of subscriptions through their business offices, they handled some 125,000 transactions. While this represents but 21 percent of the estimated total stock issue transactions through all channels, including banks and brokers, it nevertheless exceeded by 49 percent the number which Associated Companies handled in 1926. Thus it is evident that the local facilities

they offered to their patrons were more widely used as these facilities became better known. Also, as shown in Table I giving the territorial distribution of these transactions in comparison with the distribution of stockholders, it was found especially welcome in the states west of the Mississippi where a large proportion of the stockholders have bought stock through the Direct Sales Plan of the Bell Telephone Securities Company.

TABLE I

1928 Stock Issue Transactions Handled Locally by Associated Companies for Their Patrons

Territorial Classification	Purchases and Sales of Rights		Subscriptions Filed	
	Number of Transactions	In Percent of Stockholders	Number of Transactions	In Percent of Stockholders
New England Group	2,932	2.6	2,376	2.1
Eastern Group	22,999	14.5	15,079	9.5
Central Group	15,621	24.5	9,724	15.3
Southern Group	2,614	16.7	1,619	10.3
Northwestern Group	4,219	35.2	2,394	20.0
Southwestern Group	9,857	46.9	6,316	30.1
Mountain Group	3,331	34.9	2,408	25.2
Pacific Group	13,273	39.0	10,392	30.5
Total	74,846	17.3	50,308	11.6

370,000 Fractional Warrants Issued

The importance of rendering every practicable service to stockholders in effecting rights transactions may be appreciated when one realizes that over one-half of the total warrants originally issued were for fractions of shares and had to be matched up in order to be utilized in subscriptions. In other words, 370,000 stockholders received fractional share warrants and had to acquire or sell rights if they were not to permit these warrants to lapse. If but 10 percent neglected to do this, more than 100,000 rights would have been left unexercised from this cause alone.

It is estimated that the Bell Telephone Securities Company, in taking care of 119,000 purchases and sales of rights for investors in 1928 through the New York and Boston offices of the American Company and through the local offices of Associated Companies, handled 34.6 percent of the total non-speculative transactions in rights, as compared with 31.7 percent in 1926 and 19.4 percent in 1924. Of course, these orders were handled by it not for purposes of profit nor in competition with brokers, but merely as a convenience to stockholders and others desiring to subscribe for stock. In fact, the average Security Company transaction, which was for 4¾ rights only, was much below the size of order brokers can profitably handle and quite a number of banks took advantage of the Bell System facilities to complete small transactions in rights for their customers. Therefore, in addition to expediting the whole stock issue procedure and greatly assisting stockholders, the completion of small rights transactions through the Securities Company represented a service to the financial community generally.

Rights Prices

On May 17, 1928, rights reached a high of $16⅛, which exceeded all prices for American Telephone stock rights since the issue of 1901. Rights later dropped to $11⅜, coincident with a general decline in the price level of securities during the subscription period, and were selling for $11¾ at the close of the offer. The average market price was twice that of the previous issue.

Subscription Results

Preliminary estimates were exceeded when subscriptions reached a record total of 265,000. This was about 40,000 more subscriptions than were received in 1926 and the percentage of stockholders subscribing

was also found to be larger. As shown in Table II giving comparative statistics for the 1928 and 1926 issues, by far the greater part, or about 78 percent, of the subscriptions were made by payment in full as compared with 76 percent in 1926 and 73 percent in 1924. However, in both 1928 and 1926 the same percentage (83.8 percent) of the shares was subscribed under the single payment plan. Just as heretofore, the larger subscribers selected the single payment plan, the average subscription being for 7½ shares as compared with 5 shares under the installment plan. The average of approximately 7 shares for total subscriptions was somewhat higher than in 1926 when it was 6¾ shares.

TABLE II

COMPARATIVE STATISTICS OF THE 1928 AND 1926 STOCK ISSUES
(1928 Figures Partly Estimated)

	1928	1926	Increase of 1928 Over 1926
Par value of stock offered	$185,863,000	$154,127,500	20.6%
Par value of stock subscribed	185,158,600	152,554,400	21.4%
Percent of Total stock subscribed under single payment plan	83.8%	83.8%	0
Number of stockholders on the record date	432,004	371,347	16.3%
Number of subscriptions under single payment plan	206,000	173,265	18.9%
Percent of Total subscriptions	77.8%	76.4%	1.4%
Number of subscriptions under installment plan	59,000	53,535	9.5%
Percent of Total subscriptions	22.2%	23.6%	−1.4%
Total subscriptions	265,000	226,800	16.7%
Number of subscriptions by stockholders	252,000	213,800	17.9%
Number of subscriptions by others	13,000	13,000	0%
Average shares offered per stockholder	4.30	4.15	.15
Average shares per single payment subscription	7.53	7.38	.15
Average shares per installment subscription	5.09	4.61	.48
Average shares per Total subscription	6.99	6.73	.26

Over $166,000,000 of payments were received as of the subscription due date, August 1, 1928. The larger payments, however, those made by banks and brokers for their own account and for their clients, were not made until the very end of the period, so that $48,000,000 was taken in and deposited on the final day alone. As only a small proportion of the total funds received was needed for immediate expenditure the balance has been invested in the highest grade short term securities, such as United States Government bonds and certificates of indebtedness and tax anticipation notes of selected municipalities. These obligations were chosen with dates of maturity or of repurchase by strong institutions coinciding with dates when the funds will be required by the Bell System. It is not the policy of the Company to loan in the call money market.

The usual statistical analysis of subscriptions has been completed only for those paid in full. Chart No. 1 shows full paid subscriptions classified as to size of subscriptions with the unshaded portion at the top of the column representing the number of new stockholders gained in each group. It also compares the results with the 1926 issue. The larger proportion of total subscribers in the lowest group indicates the great interest of small holders in the offer. In addition around three-quarters of the 10,000 new stockholders added through full paid subscriptions fell in this group.

The small amount of stock unsubscribed is now available for sale as may be determined by the Directors of the Company. Such shares in the past have, at some appropriate time, been sold at the current market price and the proceeds placed in the Company's treasury for the equal benefit of all stockholders.

Stock Issue Organization

To the Treasury Department of the American Company, an important aspect of the stock issue was the

organization and production problem it represented. Some idea of the volume of clerical work involved may be realized from the fact that more than 1,500,000 pieces of mail, incoming and outgoing, were handled within a few weeks by the Treasury Department in connection with the stock issue, not including the 430,000 dividend checks mailed in July or any of the regular correspondence handled during the period.

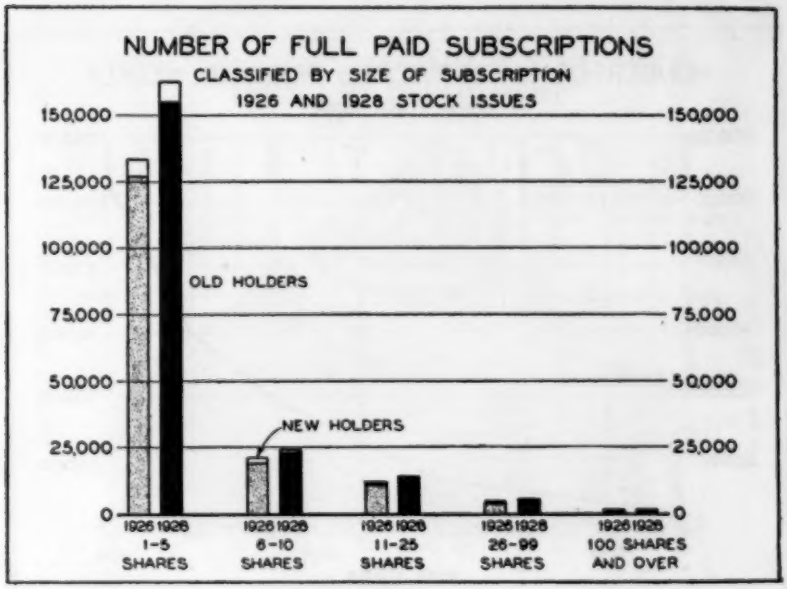


Chart No. 1.

Chart No. 2 showing the volume of subscriptions received weekly gives a suggestion of the high peak which the subscription work reached at the end of the period, when over 70,000 subscriptions were in process of being reviewed and recorded. Chart No. 3 showing the number of employees engaged in the Treasury Department indicates how the temporary forces were increased and decreased to meet the situation. During the subscription period the total personnel of the Department rose to approximately 1,000 employees, of

whom more than 700 were temporarily engaged for the occasion.

As in the case of other recent stock issues, many people were available for summer employment from the colleges and universities and it was found possible to obtain an exceptionally high grade of temporary personnel. Among 294 men so employed there were representatives from 115 educational institutions throughout the entire country. Also, as in the past, a number of

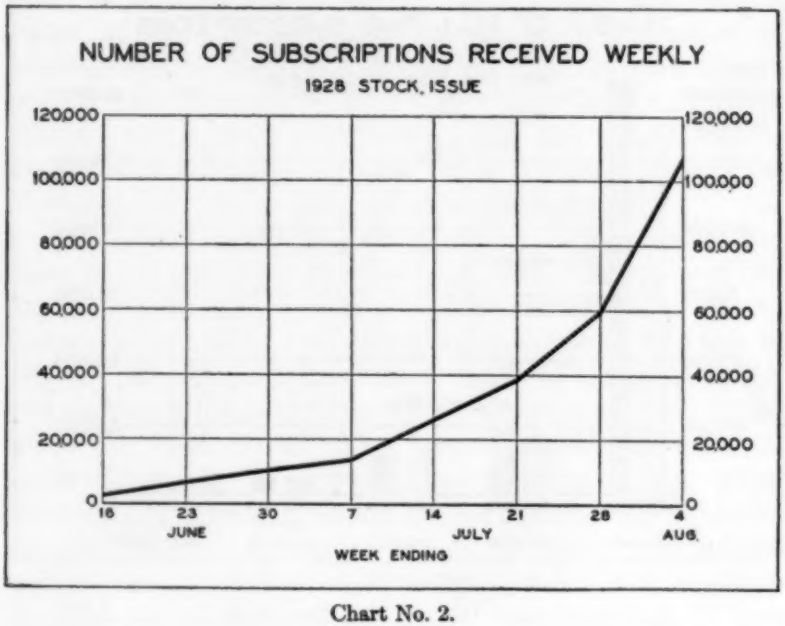


Chart No. 2.

experienced supervisory employees was secured from other parts of the Bell System to fill responsible positions in the stock issue organization and their services were found indispensable.

The training of temporary employees for their stock issue jobs has always presented some difficulty, not only because the work lasts for such a short period, but also because nothing can be done before the announcement date. This time a new step was inaugurated in the

form of a one-day school, which most of the new employees were required to attend. This school was conducted in the manner of informal conferences and the purpose was to give the new employees an over-all picture of the stock issue undertaking, which they could not ordinarily obtain once they had reported to their individual sections. Actual training in the details of stock issue work, of course, followed as heretofore after they had received their individual assignments. This

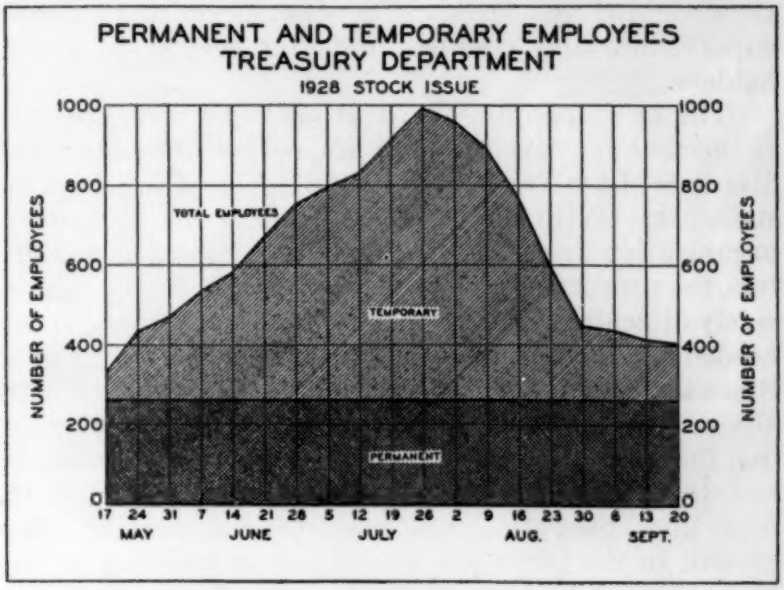


Chart No. 3.

experiment proved distinctly worth while in the opportunity it afforded of introducing these people to Bell System ideals and in the effect it had in strengthening morale for the strenuous work in hand.

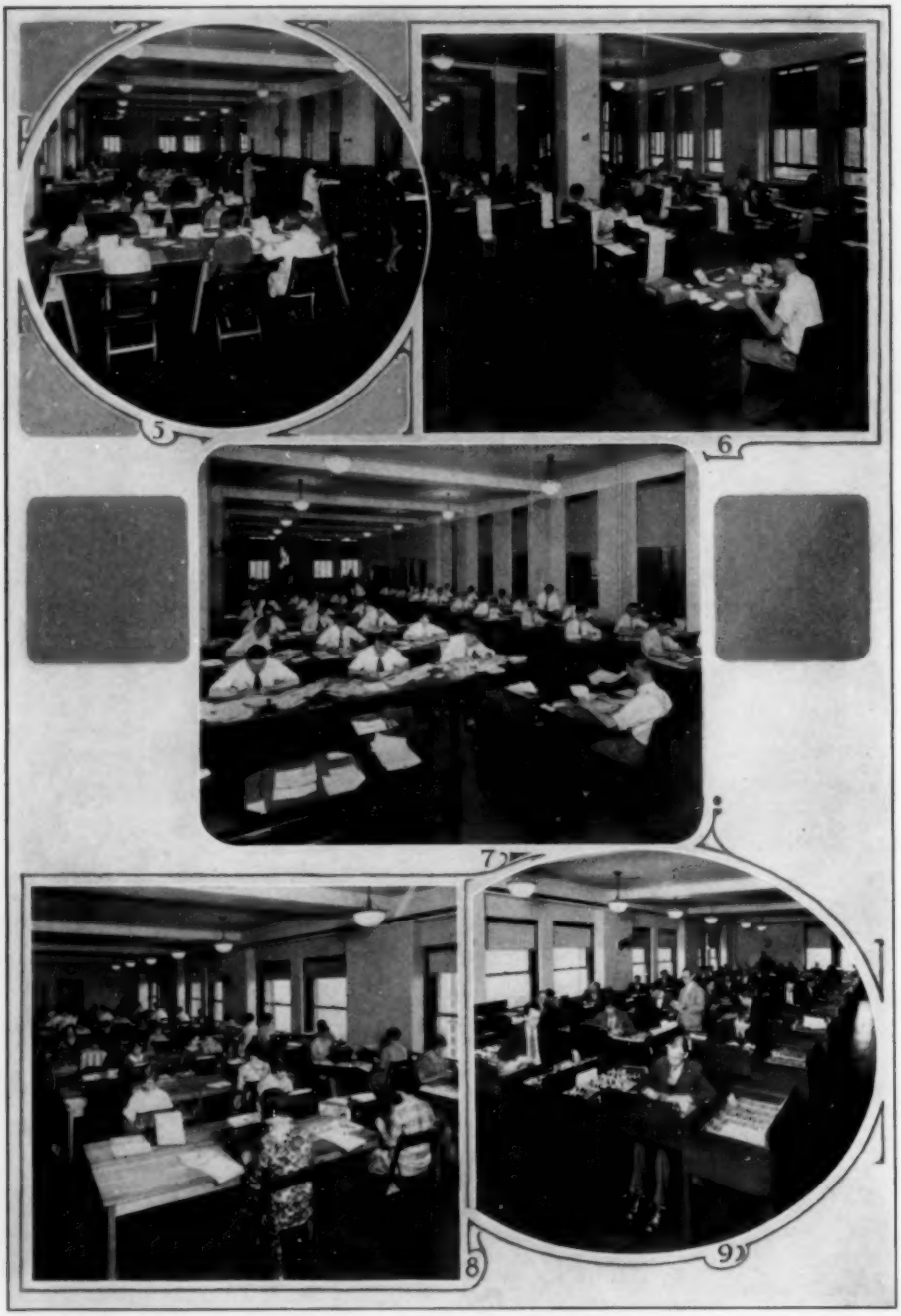
The general plan of organization for the stock issue work was substantially the same as that established for the 1926 issue. The principal change was made in connection with the handling of incomplete and irregular subscriptions requiring correspondence, which is recog-

nized as one of the most difficult tasks associated with a stock issue. In 1928 approximately 29,000 letters were received requiring individual answers, not including several thousand more which were handled by the use of printed forms. The organization for this work was divided into six sections, each performing similar functions for an alphabetical subdivision of the stockholders' list, and each provided with its own dictators, stenographers, control records, and correspondence files. This form of organization facilitated the matching up of cases in process, permitted a closer supervision, and resulted in better service to stockholders.

The accompanying illustrations show the office arrangement for several of the important organizational divisions of the Treasury Department handling stock issue work. With the increasing size of the temporary organization from issue to issue requiring office quarters, the procurement of suitable space has been progressively difficult. Estimates of the temporary floor space needed for the 1928 issue called for 38,000 square feet. Since this amount of space was many times greater than any space to be spared in the 195–205 Broadway building, for the first time almost the entire stock issue force had to be housed at another location. Fortunately, four and one-half floors reserved for central office growth in the large 104 Broad Street building of the New York Telephone Company were found available and the stock issue organization began moving in during early June. These quarters proved to be admirably suited to the work and offset handicaps which had been anticipated in handling the issue with such a division in the Treasury forces.

Financial writers have referred to this offer of additional stock as the most successful in the Bell System's history. So it has seemed in every respect; in the large number of subscriptions received, in the small amount of stock left unsubscribed and in the many

(1) A busy day at the 195 Broadway subscription counter. (2) The special telephone bureau of the Treasury Department where 25,000 stock issue inquiries were answered. (3) One of the six Service Sections handling stock issue correspondence. (4) A section of the Bell Telephone Securities organization arranging purchases and sales of rights.



(5) The bureau where the principal subscription records were filed. (6) Forty typists engaged in recording acceptances of subscriptions. (7) The organization reviewing and accepting subscriptions received by mail. (8) Preparing stock certificates for subscriptions paid in full. (9) The Bookkeeping Section where the record of certificates issued was posted to stockholders' accounts.

thousands of pleasant contacts with stockholders. The nation-wide ownership of American Telephone and Telegraph Company stock made the offer in some respects a great cooperative undertaking between Bell System employees and their investment partners in the business. The results achieved seem to measure up to the best traditions of Bell System service and no doubt are a source of gratification to the thousands of employees throughout the country who were involved.

H. BLAIR-SMITH.

A New Bell System Service in Classified Telephone Directories

A NEW Bell System undertaking which is now gathering momentum will not only add another service feature to the many now available to telephone users, but is expected to prove of importance to that portion of the country's economic structure which has to do with the problems of wholesale and retail merchandising and distribution.

Local vs. National Advertising

Practically every individual has had at one time or another the experience of reading an advertisement which has created in his or her mind the desire to purchase the product or service advertised, or at least to obtain further information about it. If the advertisement is local in its scope, such as newspaper or direct mail, then the course of the prospective customer is usually simple, since the name and address of the store or dealer handling the item is nearly always included in the advertising, thus pointing the way to a personal visit of inspection and purchase or to a telephone inquiry for additional details.

But there is a vast amount of advertising which is not local but national in its appeal. Weekly and monthly magazines with circulations of hundreds of thousands and even millions throughout this country carry many pages of advertisements of trade-marked goods and services. And the individual whose desire for possession of something so advertised is stimulated to action, finds that the next step is not quite so simple. The advertisement has accomplished its purpose in creating to a greater or less degree the wish to buy; it cannot as a general rule serve also as a guide post.

" Send for illustrated booklet and the name of your nearest retailer," it may say, or " Sold by leading dealers everywhere." But it is asking a good deal of human nature to wait perhaps several days to find out where to buy the thing in which interest is keen at the moment; while the latter may not be literally true, and the wouldbe purchaser, after one fruitless attempt or several to find a dealer who does carry the advertised article, may accept " something just as good," or give up the search entirely. In other words, there is a great deal of lost motion between national advertising on the one hand and the sale of the advertised products through retail stores and local dealers on the other. It is a situation which causes grave concern to national advertisers, is a nuisance to those who want to buy the things they have seen advertised but can't find where they are sold, and brings about economic waste in the complex system of distribution.

To Remedy the Situation

It is to help alleviate this situation that a new national service now being introduced and sponsored by the American Telephone and Telegraph Company as one more of its many contributions to the commercial and social welfare and progress of the nation.

This new service, which will enable readers of national advertisements to find where to buy the advertised products, consists in brief in the opening of the listing columns of classified telephone directories, on a national basis, for the inclusion of trade-mark headings, each trade-mark to be followed by the listings of local dealers in each directory under the slogan " Where to Buy It."

It is a new service, however, only in respect to its national aspect and to the part which the American Telephone and Telegraph Company is now taking in its further development; for it was discussed at a di-

rectory conference more than three years ago, and since that time several of the Associated Companies of the Bell System have sold trade-mark headings, with dealer listings, and more than 2000 such headings, representing a large number of different products, are now appearing in classified telephone directories in many different parts of the country.

A Necessary Preliminary

Meanwhile an important step in connection with nearly all classified telephone directories has been their "conversion," so called, to a higher typographic standard, with a better arrangement of display advertising, a more convenient and logical method of business and commodity headings, and, as a consequence of these changes, an improved service to telephone users. Most of the Bell System classified directories have already been so "converted," the remainder will be altered to conform to the new standard within the next one or two issues, and the time now appears propitious to proceed actively to enlarge the scope of the classified telephone directories by the inclusion of national trade-mark headings.

The Field of the Classified Directories

The threefold usefulness of the classified telephone directories is generally well understood. To the telephone subscriber, to either residence or business service, its business and commodity listings form a buyers' guide and a convenient reference medium. To the merchant, professional man, purveyor of goods or services, it is of equal importance in providing a directional medium toward whatever he has to offer the prospective purchaser. And to the operating telephone company, in addition to the function of a service medium of real value to its customers, the revenue obtained from the sale of extra listings of various kinds and of display

advertising in the classified telephone directories serves to offset to an increasing degree the heavy costs incurred in the publication of the alphabetical directories. Since the appearance of the first list of subscribers arranged by business classifications, the primary incentive to the publication of classified telephone directories, whether in separate volumes, as is the case in New York, Chicago, Philadelphia and Boston, or included within the covers of the alphabetical books, is to render a useful service to telephone subscribers. That is the motive which has led to the development of the present plan for the inclusion of trade-mark headings in the classified directories. It is obvious, none the less, that it is this feature of these directories which makes them of value to advertisers, since if they were not useful to telephone subscribers they would have correspondingly little use as advertising media.

So far, hower, this usefulness has been confined almost entirely to the locality in which each separate directory has been published. The telephone user who wished to find out where to purchase an article nationally advertised under a trade-mark name has in most cases referred in vain to the classified telephone directory. The national advertising bought to interest that individual in a particular product has not been able, except in special instances, to furnish this directional information. And it is this " missing link " between advertising, on one side, and the dealer and purchaser on the other, which the trade-mark headings in the classified telephone directories will supply.

Enlarging the Horizon

A manufacturer or other national or regional advertiser may now purchase a minimum space of one inch or a maximum of two inches, for the listing of his product under its trade name, and a few lines of descriptive matter, in the classified column, followed by the phrase

" Where to Buy It " and a list of dealers handling the product or furnishing the service in the locality covered by each classified directory. An example of the appearance of such headings is shown in the accompanying illustration.

Coincident with the publication of his trade-mark heading in the directories, the advertiser may incorporate in his advertising a reference similar to the following:

> Your nearest dealer is listed in your
> "WHERE TO BUY IT"
> CLASSIFIED TELEPHONE DIRECTORY
> UNDER THE HEADING———————

And by this simple expedient the classified telephone directory at once becomes more serviceable to the telephone user; the advertising dollars of the manufacturer are made more profitable; and advertiser, dealer, and consumer are brought into a closer relationship.

ADVANTAGES TO ALL

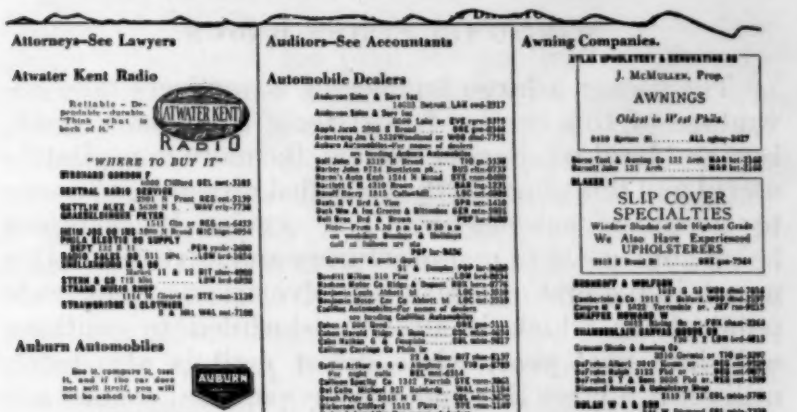
In the details of the plan many advantages become apparent.

It will minimize the necessity of " shopping around " on the part of the prospective purchaser to find the desired article, or of accepting a substitute.

It will not be necessary for the advertiser to clutter up expensive advertising space with lists of local dealers handling his product, since the one short reference to the classified telephone directories will accomplish the same purpose, while here of course the dealer listings have a permanency not obtainable in more transient forms of advertising.

The manufacturer who has nation-wide distribution can practically " blanket " the country with his trade-mark headings and dealer listings, since the classified telephone directories have a circulation of more than twelve million copies, most of them published twice a year, in more than 6,000 cities and towns in every state

in the Union. But circulation can also be made as selective as distribution requirements may indicate, and trade-mark headings and dealer listings may be purchased in directories having distribution in certain sections of the country, or in large cities, medium sized


Attorneys—See Lawyers

Atwater Kent Radio

ATWATER KENT RADIO

"WHERE TO BUY IT"

Auburn Automobiles

AUBURN

"WHERE TO BUY IT"

Auctioneers.

Auditors—See Accountants

Automobile Dealers

Awning Companies.

J. McMULLEN, Prop.

AWNINGS

Oldest in West Phila.

SLIP COVER SPECIALTIES

Window Shades of the Highest Grade

We Also Have Experienced UPHOLSTERERS

AWNINGS of All Kinds

SLIP COVERS AND WINDOW SHADES

Let Us Estimate

Section of a classified directory page, much reduced. Atwater Kent and Auburn are trade-mark headings, followed by the "Where to Buy It" phrase and listings of local dealers. Observe that both these trade-marked products are listed under their own names and that in the column of "Automobile Dealers," cross references lead to the Auburn heading and to those of other automobiles.

cities, or small communities having chiefly rural interests. Indeed, the flexibility of the service is such that it can be adapted to the needs of practically any product or service sold under a trade name.

Each trade name is placed in its proper position as a main heading, since by virtue of the fact that it is ad-

vertised under that name, it is under that name that directory users will expect to find it; but if it is a product or service susceptible of inclusion under a business or commodity heading, a cross reference will be there provided, pointing to the main alphabetical heading.

Making the Service Known

The sooner a large number of advertisers take advantage of this service to list their trade-mark headings and local retailers or dealers, the more immediately useful will this phase of the classified directories become to telephone subscribers. The service is therefore being announced to manufacturers and advertisers this month in the first of a series of advertisements in trade publications which is already scheduled to continue well into next year, while direct mail is also being utilized to a large list, and sales by personal contact are now actively being carried on. At a later date, when the results of these sales efforts become apparent, large space will be used in national magazines, supplemented by newspaper advertisements, direct mail, and other efforts on the part of the Associated Companies of the Bell System, to acquaint telephone users, including the 350,000 telephone employees and their families, with this additional service which will be found in their classified directories.

Sales activities are being undertaken in all parts of the country, since each Company of the Bell System is empowered to act as the agent and to place trade-mark headings and dealer listings in the books of any or all the other Companies of the System. A special sales organization has also been created at the offices of the American Telephone and Telegraph Company at 195 Broadway, under the Directory Advertising Manager, to engage intensively in the sale of this service, and to co-operate with manufacturers and advertisers in making an appraisal of their needs and the

extent to which the service may be applicable to their merchandising and distribution programs.

The Economic Significance of the Plan

Having its inception in a desire to enhance the usefulness of the classified telephone directories to telephone subscribers, the plan for publication of trademark headings and dealer listings in classified telephone directories is not merely a project for the development of one more advertising medium. As it affects both manufacturers and retailers, it is primarily a merchandising service. It does not compete with other forms of advertising, but is a supplement to them. As a supplement to the millions of dollars now being spent for advertising, and serving the potential purchaser, the retailer, and the manufacturer by bringing them into more effective contact one with another, there is reason to believe that this project will quickly assume national significance in lessening the cost of distribution which is a present problem intimately associated with the prosperity of the country.

J. S. Bradley.

Regional Trends and Shifts in Industry—II

THE present article adds some further illustrations of major shifts in industry between the territories of various Associated Companies of the Bell System, to those given in an article in the preceding issue of this Quarterly. The earlier article discussed briefly regional trends and shifts in bituminous coal production, lumber production, cotton growing, and wheat and corn growing. The present article will make use of illustrative examples drawn from the industries of copper mining, petroleum production, steel ingot production, cotton manufacturing, and wheat flour milling.

Copper

The copper industry in this country virtually dates back about eighty years to the opening of the first mines in the great native copper deposits of upper Michigan. That state soon became one of the principal copper producing regions of the world and ranked as the chief copper producing state in this country until 1887, when the lead was taken by Montana. Just twenty years later Montana surrendered the lead to Arizona. The rapid growth and the locale of copper production in this country during the seven decades beginning with 1845 was due principally to three causes. These were the discovery of numerous large copper deposits, the development of mining and metallurgical technology that made possible successful exploitation of these deposits, and, third, the rapid rise from 1875 on, of the electrical industries, including communication. These industries came into being just in time to make a market for the rapidly increasing supplies of copper, a metal which in addition to its other valuable qualities, has the greatest electrical conductivity per unit of cross-section of any of the non-precious metals.

Chart 1 shows over the last generation the output in the three major producing regions of the United States: (1) Michigan; (2) Montana; and (3) Arizona, New Mexico and Utah. (The figures show smelter production of copper originating in the mines of the states indicated.) It will at once be seen that the rate of growth in these three regions has been slowly diminishing, and that in two of the districts, namely Michigan and Montana, the trend of output has actually been downward since the World War.

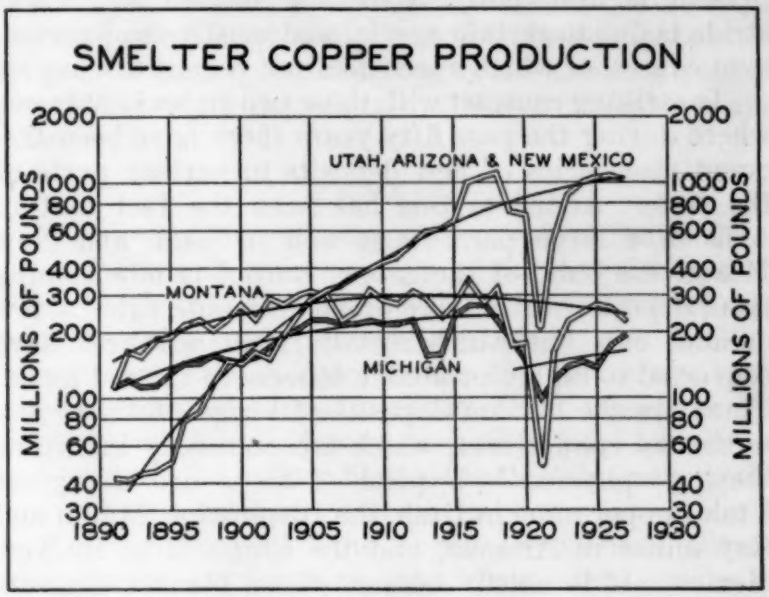


CHART 1

Entirely different as are the copper deposits and the conditions of copper mining in Michigan and Montana, the economic explanations for their downward trends of output are essentially similar. In each state copper production is confined virtually to a single region—in the case of Montana, practically to the town of Butte, the greatest copper mining camp in the world. The rich ores of the early days soon were succeeded by in-

creasingly lean ores, which at the same time were more expensive to mine because they were deeper underground. Technological advances and discoveries of new deposits in the limited copper bearing regions, however, enabled the mines of these states to continue to pour out increasing volumes of copper up to the period of peak prices during the war. The severe drop of prices thereafter, combined with higher costs, due to post-war price levels even more than to exhaustion of deposits, brought about curtailment of operations. That Michigan at present is apparently recovering toward a pre-war stride is due to certain special and mostly semi-permanent causes, of which space does not permit discussion.

In striking contrast with these two states is Arizona, where during the past fifty years there have been frequent discoveries of new deposits in various parts of the state. Added to this has been the fact that in Arizona a large percentage, and in Utah and New Mexico the bulk, of the copper output is now coming from deposits which were of no economic value a few decades ago, but which metallurgical advances have converted to highly profitable sources of the red metal. These are the blanket deposits of lowgrade finely disseminated copper ores, which are popularly known as the "porphyries." Typical of these are the great Utah Copper mine in Utah, the Inspiration, Miami and Ray mines in Arizona, and the Chino Mine in New Mexico. It is chiefly because these blanket deposits occur in all three of the states just mentioned that the states are grouped together in the chart, while the State of Montana, also in the territory of the Mountain States Telephone and Telegraph Co., is shown separately. The life of these blanket deposits is much more subject to human control and more predictable than is the life of vein mines, such as those at Butte, or the life of irregular deposits, such as those at Bisbee and Jerome, Arizona. This is because drilling can determine with far less error the extent and the ore con-

tent of the blanket deposits than of the others, and because as a result of this the rate of exploitation and therefore of output and of exhaustion is principally a function of the size of the reduction plant which it is desired to build, the metallurgical advances that may be made during the life of the deposit, and of course the market price of copper.

The domestic output of copper in the United States reached its peak during the war and has never since equalled that peak. If the country's former high record output were to be surpassed with copper at about present prices, it would presumably be chiefly because of greater output by the mines of the southern part of the territory of the Mountain States Telephone and Telegraph Co.

Petroleum

The petroleum industry in the United States dates from 1859, with the discovery of the Appalachian oil field, which until about the beginning of the present century was the largest producing field in the country. Expansion of the industry during this period was quite slow, not only because of a lack of well developed equipment for reaching and extracting oil in large quantities, but because of a rather limited and slowly growing demand for the product.

During this period the largest use of crude oil was as a source for kerosene, which came into use as an illuminant very shortly after the discovery of oil in commercial quantities. Since then, however, electricity and gas have made serious inroads on the domestic use of kerosene, but at the same time other uses for petroleum grew rapidly and the industry expanded sharply. The stupendous amount of gasoline used by the automobile industry, the vital importance of oil as a lubricant, and the extensive use of fuel oil are developments of the present century and have been made possible by the opening up and exploitation of new oil

fields. These new fields have been found principally in the territories of the Southwestern Bell Telephone and Pacific Telephone and Telegraph companies.

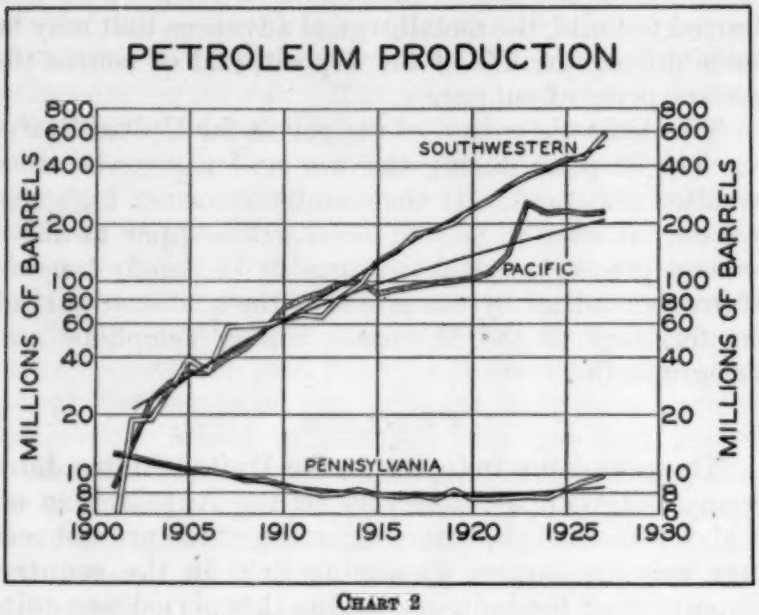


CHART 2

Chart 2 shows production from 1901 to date in these two territories and also in Pennsylvania, the most important oil producing state in the Appalachian field. It will be noticed that whereas production in Pennsylvania has become stabilized, after a long period of decline, production in the other two territories has gone ahead rapidly, although at declining rates of growth.

These rates of growth are indeed partially affected by human factors. Production in the country as a whole, in spite of serious overproduction at times, has, in general, tended to increase with consumption,—especially, in recent years, consumption of crude oil for the extraction of gasoline. The ratio of production to consumption affects prices and profits and thereby affects the amount of oil-well drilling and hence ultimately

production itself. In a given territory, however, the trend of production depends to a much greater extent upon the frequency with which new oil pools are discovered or are made commercially available by the use of improved equipment and deeper wells, and the size and quantitative and qualitative content of the pools or "fields." The nature of petroleum reserves is such that once a new pool is opened up it is rapidly exploited. The existence of oil in all the major oil-producing territories of today was known prior to 1890, though of course the exact location of the pools and their productivity have become known only through drilling. It has been the exploitation of these reserves, three-fourths of which are in California, Texas and Oklahoma, which has led to the tremendous expansion in the Southwestern and Pacific territories.

The decline of production in Pennsylvania has been checked, and an actual increase brought about in recent years by extensive drilling and by more complete recovery through the use of flooding and compressed air. The fact that production in this state was only slightly less in 1927 than it was twenty years earlier shows clearly the stability of the oil industry in this state.

Production in the Pacific and Southwestern territories has been far from stable, and it has been the sudden opening up of new fields in these regions, especially the latter, that has at times demoralized the price structure of the industry. Production in the Pacific territory increased rather steadily until 1923, when developments of the Santa Fe Springs, Long Beach and Huntington Beach fields in the Los Angeles Basin resulted in almost doubling output in the state. Since then production has remained comparatively stable,—in part, to be sure, because much output has been shut in.

In the last several years the increase in production in the Southwestern territory has been more than suf-

ficient to meet the demands of an increased consumption. Such developments as that of the Smackover field in 1925, and the Seminole and West Texas fields in 1927 have contributed to an increase of nearly 50 percent since 1924 in an already large total. It is chiefly because of these last two developments that productive capacity of the industry is at present in excess of consumptive requirements.

The application of more scientific methods in locating and extracting crude oil from the ground, and the resort to deeper drilling, which has made possible the tapping of new petroleum pools, have kept the country's production equal to or above consumptive requirements. On the other hand, the percentage of dry holes has increased materially. Furthermore there is evidence that consumptive requirements of the country will not in the future expand at as rapid a rate as during the past twenty years. For reasons connected with both supply and demand factors, therefore, it seems probable that the past *rate* of growth in the industry will not continue.

Steel

The beginnings of the modern steel industry in this country date from 1864, when Bessemer steel was first produced in the United States. Steel had been turned out in small quantities prior to this, but the advent of the Bessemer converter and, a few years later, the Siemens-Martin open-hearth furnace made possible the output of steel on a large scale. The early development of the industry was largely in western Pennsylvania. This district was located in close proximity to coal reserves and at the same time was advantageously placed as regards consuming markets.

As may be seen from Chart 3, Pennsylvania is still the largest steel-producing state in the Union, although its steel output has shown practically no growth since the war. On the other hand, steel production in the

territories of the Ohio and Illinois Bell Telephone companies, the latter including Indiana Harbor and Gary, Indiana, has continued to gain and in each case has reached levels higher than those attained during the war. Both these territories have had approximately the same rate of growth throughout the whole period,

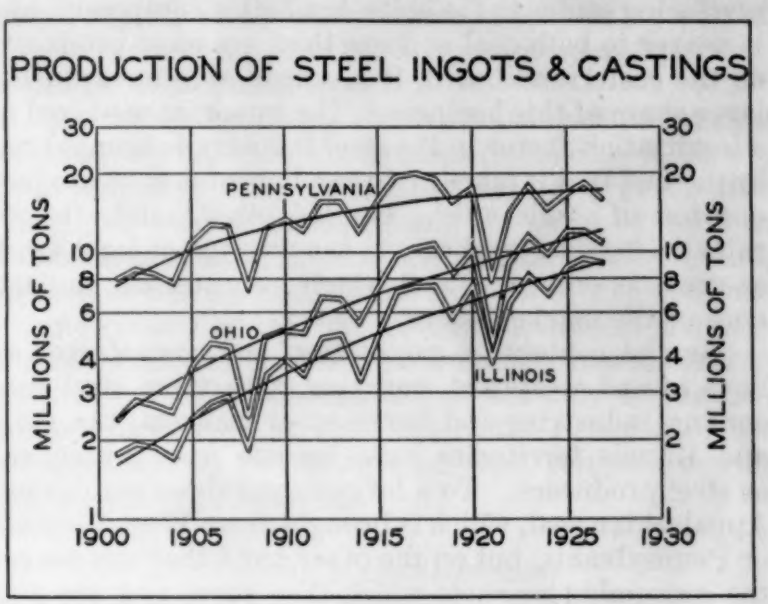


CHART 3

although in recent years the rate of increase in the Illinois territory seems to have been slightly greater than in Ohio.

Probably the two most important factors determining the localization of the steel industry in the United States are the location of the consuming markets and the availability of suitable coal reserves. The location of iron ores is of somewhat less importance, because of the concentration of our greatest ore bodies in the Lake Superior district and the ease with which ore may be transported by Lake vessels. The location of reserves of limestone, the fluxing agent, is also of less importance

than the two principal factors mentioned. Pennsylvania has long been the largest single producing state in the Union, not merely because of its proximity to huge coal reserves, but because in the past it has been centrally located for consuming markets. Since the Pittsburgh district, by far the most important steel producing center in the state, has better equipment, and is nearer to both coal and ore than are most producers on the eastern seaboard, it has been able to capture a large share of this business. The importance of coal as a localization factor in the steel industry is brought out by the fact that it takes up to two tons of coal to produce one ton of crude steel. On the other hand, freight rates on finished steel are on the average at least twice as great as on coal, a fact which indicates the importance of the market factor.

As the centers of population and manufacturing have moved westward, carrying with them steel consuming industries and hence steel markets, the Ohio and Illinois territories have become more important as steel producers. To a large extent these regions use Appalachian coal, which is brought from West Virginia or Pennsylvania, but on the other hand they are nearer the consuming markets which they serve and are also geographically and economically somewhat closer to the Lake Superior ore reserves than is the Pittsburgh district. Because of the Pittsburgh price basing point system, until recently in force, prices of steel in Chicago, for example, were the same, whether the steel was produced in Pittsburgh or farther west, and steel companies seized the advantage of serving western markets from plants located nearby. These factors principally account for the building of plants at Gary, Indiana, and at Indiana Harbor. Large plants have also been built in Ohio, serving the oil and automobile industries. There is the additional factor that, because they are newer, steel plants in the Ohio and Illinois territories are better equipped and more economical in

operation than many of those in the Pittsburgh district.

One other development in the United States that deserves passing mention is the increase in steel production in Maryland, which is favorably located as regards West Virginia coal, Cuban iron ore, and an adequate consuming market. This state in recent years has gone ahead rapidly as a steel producer, chiefly as a result of the large modern plant that has grown up at Sparrows Point on Chesapeake Bay.

The factors leading to the westward shift of the steel industry are not quite the same as in the case of the pig iron industry. The decline of pig iron production along the eastern seaboard and in parts of western Pennsylvania such as in the Shenango Valley is not, in fact, so much a shift in the location of pig iron producing centers as it is the gradual decline of one particular branch of that industry, namely merchant iron production. This decline is due not only to the displacement of iron by steel but to the invasion of the iron market by the integrated steel companies with lower costs of production.

Cotton Manufacturing

The cotton textile industry in the United States virtually dates from 1790, when a plant was established in Rhode Island by Samuel Slater. The invention of the cotton gin in 1793, which made possible cheap production of raw cotton on a large scale, and the imposition of protective tariff duties contributed to the rapid growth of the industry. The birth of the industry in New England, the abundance of water power there, and a ready supply of high grade labor, early gave that territory a dominant position in the industry. Expansion of the New England textile industry continued until just after the war, when a decline set in, as a result of extensions of the industry in the Southern Bell Telephone territory. The extent of this shift is brought out by the

fact that in the year ending July 31, 1927, the number of spindles active at some time during the year in the territory of the New England Telephone and Telegraph Company was 18½ percent less than in the year ending July 31, 1921, whereas the number of spindles active in the Southern territory increased in the same period by a little over 13 percent. The decline of cotton mill activity in the New England territory has been reflected not only in the lack of building of new mills but also in the dismantling of a number of mills formerly in operation.

Chart 4 shows the number of spindles active in these two territories since 1906. It will be noticed that even prior to the war the rate of growth in the Southern territory was greater than in New England. The latter had, in fact, shown distinct signs of a diminution in its rate of increase, although at that time there were no signs of an actual decline. Since the war, however, competition of other fibres and a reduced demand for certain types of cotton goods have retarded the growth of the industry in the United States as a whole, and accordingly the continued growth of the industry in the Southern territory has meant an actual decline of the industry in New England.

Unlike the steel industry, nearness to raw materials and consuming markets has had only minor significance in determining localization of the industry. Human factors have always played a dominant role in the industry, and it is such human factors as a cheap labor supply, labor legislation more favorable to the mill owners, and lower taxes which are now operating in favor of the Southern territory. The development of a large supply of cheap power has also helped. These advantages, however, are perhaps only semi-permanent in nature and it is not unlikely that their effect will at least be moderated in the future.

The Southern territory is at present favored with a comparatively large supply of cheap labor, willing and

economically able (partly because of climatic conditions) to work for lower wages than the Northern operator. The labor, it is true, is less skilled than the average New England mill operative, and accordingly Southern mills in the past have tended to restrict themselves to coarser fabrics and plain cloths, where the premium on skill is at a minimum. That this labor is unorganized and not likely to indulge in widespread strikes, is also a factor.

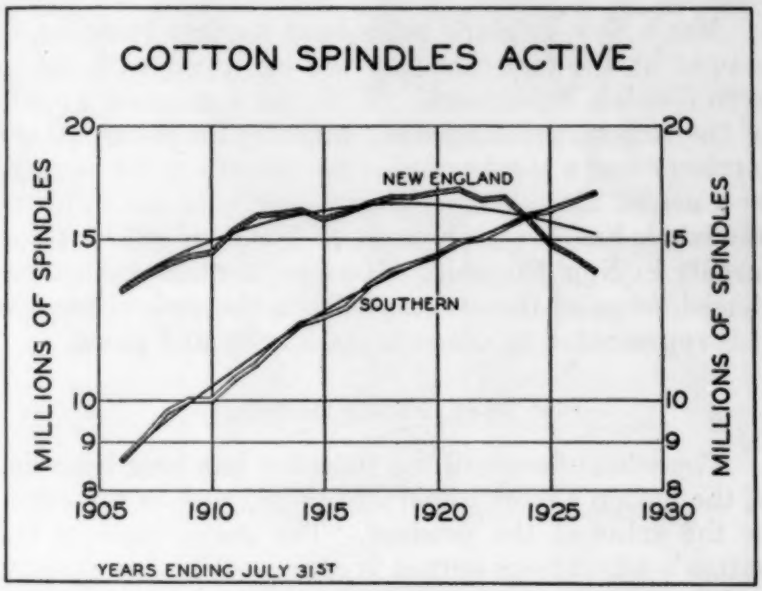


CHART 4

Another set of factors arises from state regulations limiting the hours of labor. That this is an important consideration favoring the South cannot be denied. Mill operators can operate longer hours and turn out more cloth in a given period with the same amount of equipment. With only about 20 percent more active spindles than in New England during the last year, as shown on Chart 4, the Southern territory consumed about three times as many bales of cotton. That this

is only partly due to the fact that Southern mills generally produce a somewhat coarser grade of cloth than New England, is brought out by the fact that the former averaged over 300 active spindle hours monthly per active spindle, whereas the monthly total was only about 200 hours in New England. Incidentally, the costliness to New England mill owners of absolutely or relatively idle equipment is only increased by such disparities in taxes as exist between New England and the South.

Many New England mills have further been handicapped by the fact that they are equipped with old or even obsolete equipment. With the continued growth of the cotton manufacturing industry in the Southern territory and a slowing up of the growth in the country as a whole, the resulting overcapacity, in the industry as a whole has, in part because of this fact, had its effect largely in New England. Here as in other industries, indeed, some of the overcapacity is theoretical because it is represented by obsolete machinery and plant.

Wheat Flour Milling

The wheat flour milling industry has long been one of the nation's most important industries, as measured by the value of the product. The major part of the nation's wheat flour output is consumed in this country and the industry has grown only just about fast enough to meet the increase in domestic requirements. Since per capita consumption of wheat flour has actually declined since the beginning of the century, the rate of growth in output has been even less than that of population.

Although the production of wheat flour increased only about 12 percent between 1901 and 1927, fluctuations in different sections of the country have been quite marked. The amount of wheat ground by mills in the territory of the Northwestern Bell Telephone Com-

pany, as reported by the Census of Manufactures, decreased slightly between 1904 and 1925, from about 139,000,000 to 134,000,000 bushels. During the same period, consumption of wheat by flour mills in the Southwestern Bell territory increased from 92,000,000 to nearly 140,000,000 bushels, and the mills of that territory now grind more flour than those in any other Associated Company territory. Production in the New York Telephone Company territory (represented principally by Buffalo) has also expanded considerably, especially in the last few years.

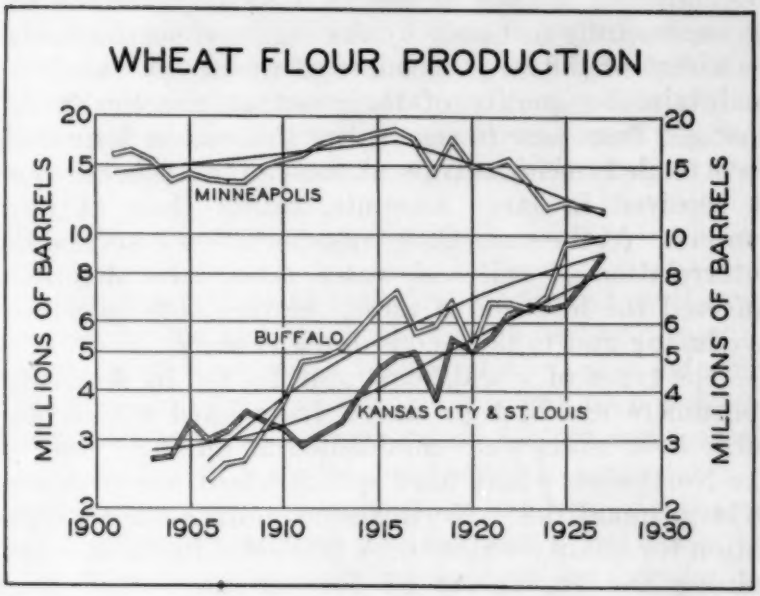


CHART 5

Chart 5 shows yearly production of wheat flour in four cities located in these three territories. Production in these cities, while not at all indicative of the comparative amounts of flour ground in the three territories, nevertheless in this case gives a fairly reliable picture of the shift of the industry from one territory to another. Annual figures are available for the cities,

while they are not for the territories; hence the use of the city figures. Production at Minneapolis, in the Northwestern territory, declined over 35 percent from 1916 to 1927, whereas Buffalo increased its output over 40 percent, and Kansas City and St. Louis (in the Southwest) together increased theirs by over 75 percent.

As a general rule flour can be most successfully milled by large concerns. This arises from the nature of the demand for the product. Demand in this country, especially in cities and industrial centers, is for standardized brands of flour. This requirement can be successfully met only by the bigger concerns, which by virtue of the large amounts of wheat consumed can maintain the quality of their output practically unchanged from year to year. For this reason flour mills have tended to concentrate at those points where wheat is received in large amounts, rather than at local centers. At the same time, transportation costs and the interrelation of rail and water rates, have definitely affected the location of mills, relative both to wheat-producing and to flour-consuming centers.

The types of wheat flour most desired by American consumers are best produced from hard wheat, and large flour mills were established at an early date in the Northwest, where hard spring wheat was produced in large quantities. Northwestern mills gained a reputation for quality which was a powerful factor in maintaining the supremacy of the territory. In recent years, however, this factor has been of declining importance. Spring wheat production in the Northwestern territory, moreover, has shown no increase during the past twenty years and more recently has, in fact, tended to decline slightly. At the same time, production of hard winter wheat in the Southwestern territory, and of spring wheat in Canada, has expanded considerably. Flour produced from these wheats is equal in quality to Northwestern flour and increasing

amounts are being milled annually. Some of the principal factors affecting shifts in wheat production in this country were dealt with in the preceding article.

Buffalo, in particular, has been favored not only as regards location with respect to the Eastern consuming markets but also because it is the natural receiving market for huge amounts of Canadian and somewhat smaller amounts of Northwestern wheat. There is a distinct saving in freight rates if wheat is sent east by lake rather than by rail, and to this Buffalo owes some competitive advantage over Western flour milling centers. The movement of wheat to this center has increased over fourfold since 1905 and the output of flour has increased correspondingly. Buffalo also has a marked advantage as regards foreign markets, and fair amounts of Northwestern wheat, and also Canadian wheat imported in bond, are ground for export.

Summary

The ten examples of shifting economic activities discussed in this and the previous article are illustrative of some of the diverse influences that may determine the location of those activities. It will be noted, however, that usually a single set of factors dominates in bringing about a decline of output in an industry of one territory and an increase in another. In the case of the lumber, copper and petroleum industries, the dominant factor has been the richness and extent of raw material resources. The geographical location of the reserves in relation to the market for the finished goods is not a vital factor, since in none of these are transportation costs a determining factor. As new or richer reserves have been discovered or have been made commercially profitable, these three industries have naturally tended to follow the raw materials, even though in each case this has taken the industry further from the chief consuming markets. This is also true to a cer-

tain extent of the coal industry, although in this case certain human factors, pertaining to labor, have played an important part in a shift of the industry to the Chesapeake and Potomac and the Southern Bell territories.

In the steel industry, on the other hand, the geographical location of iron ore and coal, and, to a lesser extent, of limestone, the principal raw materials, is of considerable importance, since transportation costs play a dominant role and are an important item of expense. The industry is so located as regards raw materials and the consuming markets as to minimize transportation costs. In cotton textile manufacturing, human factors such as labor supply and labor legislation are determining factors to the practical exclusion of any influences of transportation cost or the location of raw material supplies. The rise of the Southern territory industry does not result from the proximity of raw cotton, but, in part, because it can employ cheaper labor and work longer hours. As a matter of fact, as pointed out in the first article, cotton growing has tended to decline in the Southern Bell Telephone territory, and to increase in the Southwestern Bell territory, which is geographically quite removed from the principal southern mill centers.

Cotton growing depends on soil and weather conditions. These, for the most part, are of importance because they have considerable effect on the destructiveness of the boll weevil, whose ravages, in recent years, have been most extensive in the Southern Bell territory. Shifts in corn and wheat growing are due to factors of soil and weather conditions and also to the comparative advantages of growing wheat or corn in a given territory. Shifts in wheat growing are of considerable interest to the flour milling industry, which tends to concentrate at those points where wheat of a suitable variety is brought to market in large quantities.

It has not been the purpose of this and the preceding article to give an exhaustive list of shifts in the location of industries during the past thirty years or an exhaustive list of the factors affecting them. Furthermore, the illustrations used have been conditioned in part by the availability of statistics. The examples indicate the sorts of inter-territorial influences which often play an important part in the growth of the principal industries in a given territory. As was stated in the first article, " the varying importance of such factors and their constantly changing effects on the industrial structure give rise to the so-called regional shifts of industry." It is because these shifts, not only in industrial, but also in mining and agricultural activities, may have at times an important bearing on the present welfare and future possibilities of an Associated Company territory, that a study of the economic structure of that territory may well be supplemented by a study of outside influences and of industrial rates of growth both within and without the territory.

WILLIAM M. LARRABEE.

Standard Quality

CONSOLIDATED purchasing in greater quantities lessens sales, buying and inspection costs and in the long run results in lower prices. Centralized manufacture in larger lots reduces overhead expense, allows a greater use of special-purpose machinery, and reduces unit production costs in many other ways. Corresponding advantages accrue from unified plans for the warehousing, distribution and installation of equipment. Standardization of the design and service requirements placed upon the commodities dealt with, however, is fundamental to the satisfactory functioning of such centralized organizations, and is essential if their indicated economies are to be realized. With this in mind, the Bell System has fostered standardization of requirements as a fixed policy.

Along with the economies which have followed standardization and the centralization of functions such as those mentioned, have come other advantages and savings, not so obvious, but none the less real. Outstanding among these is the forehanded engineering of our apparatus and equipment for maximum utility. This has involved standardized quality requirements just as design and operating engineering have arrived at uniform requirements in their fields.

Standards of Quality are not in any way a new conception of course, but the basis of such standards within the Bell System is perhaps unique. Possible profit in the manufacture or sale of equipment plays no part in their determination. Neither is the quality of Bell System apparatus required to meet the competition of inferior articles selling often at lower prices. Maximum utility for every dollar invested is the sole test.

It is fairly obvious that such standards of quality can at least be approximated in those types of equip-

ment which the System manufactures for itself. Their attainment is the constant aim of the Western Electric Company. But the willingness and even enthusiasm with which a number of other manufacturers have co-operated in attempting to meet Bell System requirements along these lines has been most gratifying.

Ideal and Practical Standards

If we ask what should be " Standard Quality " in the Bell System, we experience at the outset a need for a quantitative evaluation of the term and we recognize that the locus of such a value must be in the battle-ground of two opposing forces. Communication equipment must give good service and it must be produced cheaply. The first criterion calls for high quality standards—attempts to satisfy the second will tend to lower them.

In tracing the steps from the design of a piece of telephone apparatus through its production in quantity, several conceptions of quality come into view. So far as economy will allow, its design must specify that it be made of materials best adapted to enable it to do its work well, and must require that it be formed or assembled in such a way that it will function perfectly. That is, a piece of apparatus cannot in general be made of platinum, even though the use of platinum might result in a better piece of apparatus, unless the platinum piece can be expected to have an additional value in service equal to the cost difference between the platinum piece and a piece made of some other material. An economic design may not in general specify the form of a piece of apparatus in such a way as to require that it be machined, unless the machined piece will be worth correspondingly more than a punched piece.

After all of these major design questions have been settled however, a decision has not necessarily been reached as to just how well the piece of apparatus should be made within their limitations. To render

the best service of which it is capable, the raw materials of which it is made must be of just the right chemical composition, etc. Corresponding optimum values exist for each of its dimensional and adjustment characteristics. An analysis of the conditions under which the piece of apparatus is to carry out its daily tasks enables the design engineer to set down an ideal magnitude for each such characteristic which would result in the best overall performance in service. If it were possible to make similar units exactly alike—each one conforming to these ideal magnitudes in every detail—we would have product of economic design and "Ideal Quality."

Such an ideal of quality is a very desirable one, but it can only be approximated. No two units of any product can be made exactly alike, but even if it were possible to make them so, it would not be an economical procedure. Design specifications commonly meet this situation by giving in addition to each ideal magnitude stated or implied, a tolerance or allowable variation in that magnitude which when not exceeded will still insure a satisfactorily serviceable piece of apparatus or equipment. For example the thickness of a diaphragm must be held between limits of 0.019 and 0.021 inch—the resistance of a relay between 190 and 210 ohms, etc. Such limits are based on analyses of the functions of the particular type of apparatus or equipment when operating with other commercial apparatus and equipment in the System, and are presumably so set that with proper allowances for wear, etc. wider limits might render the combination inoperative or reduce its operating efficiency or serviceable life to an undesirable extent. A lot or quantity of product, every unit of which is entirely in conformance with the specification requirements may be referred to as of "Specification Quality."

Specification Quality is what the Western Electric Company and our other suppliers set out to attain.

Between the successive steps of manufacture and before the delivery of the finished product to the Associated Companies, they interpose process inspections which vary through a considerable range of accuracy and thoroughness. The more careful these inspections the more closely will output conform to its requirements. For many of the more important characteristics, it is essential that every unit of output meet its specifications in every detail. As an example of such a characteristic, we may consider the inductance of a cable loading coil. A case of such coils is an expensive thing. It ordinarily contains exactly the number of coils required to load the circuits of the cable in which it is to be installed. One coil defective in inductance and included in a cable circuit may render the whole of that circuit inoperative, particularly if it uses repeaters. Hence no such defects can be tolerated in a loading coil case. To meet this sort of a requirement it is necessary to make a complete and accurate inspection which will serve as a reliable sieve in weeding out the bad units.

On the other hand there are many characteristics in respect to which it is not so essential that every unit of output conform exactly to specification requirements. The defect may not be one which actually interferes with use. A unit such for example as an eyebolt, may cost relatively little, and defects which would render it unsatisfactory for service may be obvious when it is about to be used. Under these latter conditions defective units might very well be discarded at the time or they might be returned for repair at a lesser total expense than would be involved by their elimination through inspections during or at the completion of the production process. Again there may be instances where occasional units slightly exceed the specification limit for a dimension or other feature of lesser importance—one for which an absolute limit has been set as a practical expedient. The effect on service of a small percentage of such marginally defective units may be

imperceptible compared with the cost of insuring one hundred percent conformance with requirements. This sort of consideration leads to the conception that there exists an " Economic Quality " for each type of product, one which can be specified at least in part in terms of the average degree of non-conformance with specifications. This average must in general be low, for a Telephone Company is entitled to make complaint against and to receive replacement or credit adjustment for any equipment which is delivered to it and which is not in entire conformity with the specifications.

Cost and Value Determine Economic Quality

Consideration of Economic Quality from another point of view may possibly give a little clearer picture of what is meant by the term. Suppose we make a diagram, drawing first the hypothetical curve which will express the relation between the unit cost of a certain type of apparatus and its average quality. Suppose we show average quality along the horizontal axis (Figure I), and unit cost in dollars along the vertical one. Obviously, our unit-cost curve cannot go further to the right than a line representing " Ideal Quality," which we will fix arbitrarily at (*cd*). There can be no better quality than this, and its cost will be inestimably high. From that point the cost curve will fall pretty rapidly as the quality becomes poorer, until it approaches some such figure as say, the minimum possible cost of the worst grade of raw materials and workmanship with which the apparatus could be produced. In the neighborhood of this latter point, the cost curve would be approximately horizontal, and it is reasonable to suppose that between these two points it would in general be concave upward essentially as indicated in Figure I.

Now let us look at the apparatus in question from the standpoint of its value in the long run to the Bell System, in the particular use for which it is intended. We may assume of course that no such apparatus will

be produced at all except at a cost equal to or less than the minimum cost of achieving equally satisfactory results by the use of some different type of apparatus. Included in the costs in both of the cases mentioned must be all capital, depreciation, maintenance, operating and other expense involved. This minimum cost of achieving equally satisfactory results by any other means, thus establishes an upper limit for the unit

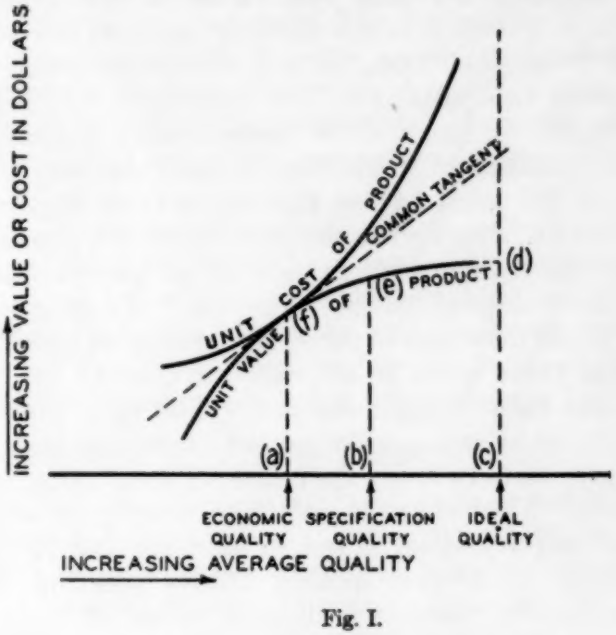


Fig. I.

value of the apparatus to the System. If the type of apparatus in question can be made for a total cost less than this limiting one, it will be made. It will no longer be worth what it would cost to accomplish the same results by some other means however, since they can now be accomplished for less with the apparatus in question. In the long run, the general operation of the law of supply and demand in the raw materials and labor markets may be relied upon to bring the value of the apparatus to the Bell System into equality with

its cost to the System. Since the System is itself either actually or potentially the producer of all of its equipment, this is equivalent to saying that if a type of apparatus is to be generally used by the Bell System, then its value to the System in the long run must equal its total production cost.

With this conception of value, let us now add to our diagram the hypothetical curve which will express the relation between the long run value of the type of apparatus in question to the Bell System and the average quality of that apparatus. We know from experience that this unit value for apparatus of " Ideal Quality " will in general be considerably below the cost of apparatus of that quality, and we may represent it by the point (*d*) on the line (*cd*) of Figure I. Since point (*d*) represents the unit value of apparatus of Ideal Quality, no such apparatus of poorer qualities can have higher values than (*d*). If it is economical to produce the type of apparatus in question at all, then there must be at least one quality (*f*) for it where its value equals its cost. The fact that its long run value at any quality cannot exceed its cost for that quality, follows from the conception of value outlined above. That there is only one quality at which value and cost are equal is not so obvious, and in fact the existence of several quality values meeting this condition may be possible with some types of apparatus. It will be fairly obvious from the consideration which follows however, that these multi-values will in general lie so close together that they may be considered as one for our present purposes. We have thus located at least one more point (*f*) on the unit-value versus quality curve for the type of apparatus in question. For quality lower than (*f*), our curve must fall off more and more rapidly as indicated in Figure I, as the quality of the apparatus approaches uselessness.

This line of reasoning has established the general

shapes of the unit-cost, and unit-value curves for varying qualities of any type of apparatus or equipment. The unit-cost curve starts for Ideal Quality at a very high figure, is in general concave upward, reaches a condition of essential tangency with the unit-value curve at point (*f*), and thereafter tends to become parallel with the quality axis. The unit-value curve starts for Ideal Quality at a figure substantially lower than the unit-cost for that quality, is parallel to the quality axis at that point but thereafter is generally concave downward, reaches a condition of essential tangency with the unit-cost curve at (*f*), and thereafter falls off with increasing rapidity. It is the quality at this point (*f*) to which we refer as " Economic Quality."

It is conceivable that under certain conditions " Specification Quality " might fall on the quality axis at a point below Economic Quality, but it will be fairly obvious from the discussion already given that Specification Quality will ordinarily fall between Economic and Ideal Qualities as indicated in Figure I.

Economic Quality is More than an Average

While the above consideration may provide a conception of what is meant by Economic Quality, its definition as an average degree of non-conformance with specifications is not enough. Suppose we consider several years' output of a particular type of apparatus which is made in quantity. As it comes from the factory or factories, this total product will be made up of a very large number of individual lots. Suppose every one of these lots to have been carefully examined and the exact percentage of defective units in each lot to have been accurately determined. The average of these defective percentages will very closely approximate what is generally referred to as the " Process Average " —that is, the average percent defective to be expected in lots resulting from the production process. If now

we divide the percentage scale into a number of bands of equal width and if we assign to the percentage value for the middle of each band all lots showing defective percentages within that band, we can then plot a curve which may have somewhat the form shown as Curve 1 in Figure II. In any particular case, this curve may not be symmetrical as we have drawn it, but such symmetry is immaterial in our present consideration.

As indicated by Curve 1 of Figure II, some of the lots will contain relatively large percentages of defective units. Some of these latter lots may even be so

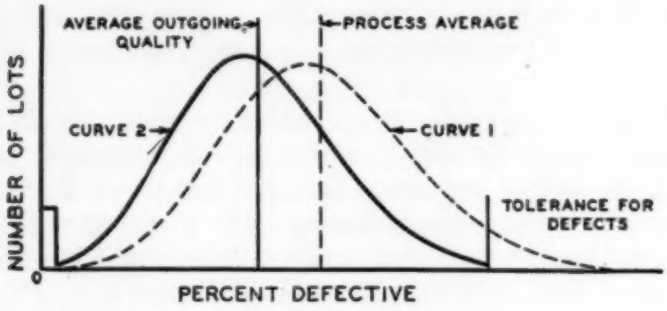


Fig. II.

largely defective that it would be uneconomical to deliver them to an Operating Company and expect the latter to weed out the bad units and to discard, repair, or return them on complaint. There must thus be also an economic limit to the departure of individual lots from Specification Quality. Such limits are usually expressed as tolerances for defects, and are of the nature of allowances for lots of product corresponding to the dimensional or other allowances for units of product. Since the specified characteristics of a piece of equipment vary considerably in importance, an individual tolerance for defects is customarily set for each inspection characteristic. An individual curve (such as Curve 1 of Figure II), together with its corresponding process average and tolerance for defects may thus

be conceived of as existing for each characteristic of the output of each type of material, apparatus or equipment used by the Bell System.

At the completion of the production process then, the product must pass through some sort of inspection designed either to eliminate those lots in which one or more of the tolerances for defects have been exceeded, or to remove from such lots at least enough of the defective pieces so that they no longer exceed any of the tolerances for defects. In a completed central office installation for example, such essentially fundamental characteristics as those affecting the operation of message registers have zero defect tolerances, and every message register is carefully inspected individually for them. On the other hand, less important characteristics of the installation, such as the finish on relay can covers, may have defect tolerances of several percent, and the proportion of relays actually inspected for such a characteristic may run as low as fifteen or twenty percent in a large office. This does not mean necessarily that such defects will always remain in the central office. Rather it points to the System economy of permitting the tail ends of less important types of defects to be cleared out by the Operating Company people in the course of routine maintenance of the office. But it is very important to find out what allowances of this sort can be justified and in cases of doubt to fix the defect tolerances on the side of safety.

The thoroughness of the inspection made at the completion of production hence varies with the type of apparatus or equipment and with the importance of the characteristics inspected for. A sufficient portion of every lot is inspected however, to insure to a predetermined degree of precision that no lot is passed in which a tolerance for defects is exceeded. In making such partial inspections, standard procedure requires the repair or rejection of all individual pieces found

defective, even though there is no indication that the lots in which they occur contain defects in excess of the tolerances for defects. Lots which are indicated by the partial inspections as containing defects in excess of the tolerances are then inspected completely and all defective pieces are either repaired or removed from them before acceptance. Practically all lots containing any defective pieces whatever are thus improved by the repair or removal of some defective pieces, and the worst lots have all defective pieces repaired or removed from them. The distribution of defects in the lots after such an inspection process will thus be somewhat as indicated in Curve 2 of Figure II. The average of the defective percentages indicated by this second curve approximates very closely what is sometimes referred to as the " Average Outgoing Quality." It is the average percent defective to be expected in lots resulting from the production and inspection processes which have been set up to provide the type of apparatus in question for the Telephone Companies.

Our picture of the " Economic Quality " for the output of a particular type of apparatus or equipment has thus broadened into a distribution curve (such as Curve 2 of Figure II) the general shape of which is determined by the production and inspection processes involved, and the more important boundaries of which are fixed by the specification of Tolerances for Defects and by limitations imposed upon the Average Outgoing Quality.

Economic Equilibrium is the Aim

The exact determination of the cost and value factors involved in Economic Quality is often difficult of course. A production process can be checked for economic balance however, by noting the effect on cost and value for a given change in quality. To do this, the process averages for the various characteristics of the

type of apparatus or equipment under consideration must be determined from past experience or from inspection data obtained for the purpose. The production cost can then be distributed among these characteristics, and any given modification in the process average, the tolerance for defects, or both for any characteristic can be expressed directly in terms of increased or diminished production cost. The corresponding increase or decrease in the value of the apparatus or equipment to the Telephone Companies can at least be estimated, and the effect of the given modification on the cost and value balance can thus be approximated. Such a procedure is obviously not limited in application to product in its finished state, but can be applied in the various stages of the production process. Insofar as it is intelligently applied to all types of new equipment, the product of our various suppliers will approach our desired quality standards.

The above discussion has endeavored to picture broadly the Quality Standard which we are aiming to attain in the large quantity of new apparatus and equipment which is constantly being added to the plant of the System. This Standard is an economic one—aimed at giving to the Operating Companies a maximum of utility for every dollar invested. An attempt has also been made to outline a few of the more important factors which enter into the evaluation of this Standard and which are being watched and studied continually to insure the quality of the plant.

G. D. EDWARDS.

Editor's Note: Mr. Edwards is Assistant Inspection Engineer of the Bell Telephone Laboratories.

By-Products of Telephone Research

THERE may be either one of two motives behind scientific research. On the one hand, there is the motive of adding to human knowledge, in which case the research is customarily referred to as " pure," and as recompense for the labor and money involved comes the intellectual satisfaction of having successfully unraveled some puzzling secret of Nature. On the other hand, research may be carried on with the idea of adapting its results as quickly as possible to some practical and useful end, in which case it is customary to call it " applied "—hopefully anticipating a successful application.

Aside from the difference in attitude on the part of the sponsor of the program, pure and applied research are identical. There may, indeed, be no difference in attitude on the part of the research workers themselves. These two branches of scientific endeavor enter equally deeply into the secrets of the universe; they avail themselves of the same instrumental and other aids to investigation; and, indeed, in any given field they frequently overlap. They are, in fact, the same thing seen from different viewpoints.

Applied, like pure research, is ceaselessly adding to the store of human knowledge, and like pure research is likely to find practical application in diverse and unexpected ways. It usually yields its sponsor the information he sought. It frequently opens up additional possibilities of which he originally scarcely dreamed. An outstanding phenomenon in the progress of science is that advance in one field almost invariably makes advances possible in other fields. Out of developments in electricity came many applications of electrical science to chemistry; these advances in chemistry reacting in turn to increase our knowledge and applications of

electricity. Countless illustrations from a wide diversity of fields could be cited. The purpose of this article is to illustrate the fecundity of science by describing some striking instances from telephone research.

The program of telephone research as supported by the American Telephone and Telegraph Company for the benefit of the operating companies of the Bell System is directed steadfastly toward the goal of better, more comprehensive and less costly service for the customer. Those who are responsible for directing this program of research look far into the future. They are concerned not only with the minor problems that arise from day to day but also with broad developmental tendencies which may find expression in the nation's telephone system only after the lapse of years or even decades. Herein lies an adequate explanation of the rapid advancement of the telephone art in America during its half century of life. The number of separate lines of research if they permitted of distinct enumeration would be well up in the hundreds and the number of problems which have been proposed and solved would total tens of thousands. The information gained by these researches is today combined in certain ways for direct application to the telephone art. In the years to come and when supplemented by new discoveries, it may be combined in quite different and more effective ways for the benefit of the telephone user. Most telephonic devices are like a child's building blocks, susceptible of combination in a variety of ways and many of the combinations seem, upon superficial examination, quite different from the telephone itself.

Somewhat over a year ago, an announcement was made that a commercial type of talking motion picture had been developed in the Bell Telephone Laboratories. This led many persons to wonder why a talking motion picture should result from investigations carried on to

improve telephone service. The line of descent is simple and direct. It has involved the bringing into harmonious association of devices which are of use in telephony although not in the particular ways required by the new association.

Out of researches directed to the improvement of the familiar telephone transmitter and receiver came, on the one hand, various high quality transmitters. One of these is now employed in the public address system and is also in well-nigh universal use for " pick-up " in radio broadcasting. On the other hand, there came the loud speaking receiver now generally known in many different forms. Out of researches underlying the telephone repeater—itself an amplifier—came a wide variety of amplifiers for speech and other uses, of capacities ranging from that of the tiny deaf set which can be carried in the pocket to that capable of projecting a speaker's words to an audience of 100,000 persons.

Such devices as improved or special forms of transmitters, receivers and speech amplifiers are, in the hands of the telephone engineer, so many building blocks and can be combined in various ways to meet various needs. One of these special combinations, perhaps as well known as any, is the public address system. Another takes the form of a perfected phonograph. These, in turn, have been merged by special adaptation to form part of the talking motion picture system.

The phonograph for talking motion pictures must employ large records capable of running for 15 minutes, a single sound record accompanying each reel of film. In the improved phonograph which has emanated from the Bell Laboratories have been incorporated studies along such diverse lines as mechanical vibrating systems, speech amplifiers and the transmission of telephonic currents through electric networks. It was necessary to perfect both the reproducing instrument and the method of cutting records.

The principles that guided the redesign of the

phonograph itself, strikingly display the unity that pervades nature. The exact statement of the flow of telephone current through an electric circuit leads to certain mathematical expressions that are similar to those expressing the flow of mechanical vibrations through such a sound transmitting device as the phonograph. The phonograph needle is not perfectly rigid but bends slightly sideways when tracing the undulating line of the record. It, in turn, drives the elastic diaphragm through an appropriate coupling mechanism. The column of air contained within the horn, to the small end of which the diaphragm is attached, is likewise an elastic member. All of these moving parts have mass or inertia, elasticity or springiness and their motion involves some friction. These quantities are analogous respectively to the inductance, capacity and resistance of electric circuits.

To every electric circuit there is therefore an analogous mechanical " circuit " possessing the same sound-transmitting properties. Telephonic circuits have been the object of study in our laboratories, almost since Bell's invention of the telephone, and an extensive knowledge of their characteristics has been accumulated. Thus the simple telephone line will attenuate some frequencies more than others, with the result that the received sound, although intelligible, lacks the quality of the original one. It is possible, however, to so group and adjust the resistance, capacity and inductance (an expensive undertaking when carried out on a large scale) that except for a gradual lowering of volume level, the transmission will be perfect. The conclusion seemed warranted therefore, that a mechanical system might be built which would also transmit sound perfectly,—a much-to-be-desired property with which to endow the phonograph. To learn its proportions, the first step was naturally to change the meaning of certain symbols in a collection of mathematical expressions with which telephone engineers were already

familiar, since they expressed the electrical behavior of certain very familiar circuits. Study of the modified equations then supplied guiding principles to be followed in developing the vibrating parts of the improved phonograph. Just as the improvement of telephone lines has involved the invention of many distinct electrical appliances, so the improvement of the phonograph has necessitated the invention of many new mechanical arrangements, each of which plays an analogous part to some electrical device and whose design has been facilitated by the understanding previously gained of the latter.

The method until recently in vogue of recording upon wax records was also susceptible of great improvement. It employed a large funnel-like concentrator to collect enough sound energy from the air to drive the cutting tool through the record. The result was at best quite an imperfect copy of the original sound. Here was found another opportunity to apply several telephone developments, among them the high quality condenser transmitter and the speech amplifier. Using a suitable amplifier, the current from a pick-up transmitter is now enlarged to such an extent that it operates a magnetically driven cutting tool. Records so engraved are vastly superior to the old style, and those now known in the phonograph trade as " electrically cut " are produced in this way.

Tracing the sequence of research and application, we temporarily left the story of talking motion pictures unfinished. It now requires but a moment to describe the erection and keying of its arch. Having on the one hand a perfected public address system capable of filling any auditorium, and on the other a perfected phonograph and means for making high quality records, there remained but the two steps of associating the phonograph and public address system so that the former could operate the latter, and the synchronization of the phonograph record with the motion picture film. This

involves synchronization with the camera during exposure of the film, and with the projector during subsequent display. Means for accomplishing both these were provided by supplementary developments.

The Telephone Laboratories and telephone research have also been called upon to perfect means for recording speech photographically upon a long strip of film like motion picture film. The purpose of the sound record upon the film is the same as that of the large phonograph disc, and during reproduction is run synchronously with the pictorial film. This form of talking movie, like its predecessor, is in use in public theatres.

Here we have several illustrations of the varied applications of which scientific developments permit. Without having been originally sought after, almost as though a field when once sowed should bear several rich yields, telephone research has given such by-products as the public address system, the " audiphone " (aids to the hard-of-hearing), the orthophonic phonograph, the talking movies, and the artificial larynx. To carry the simile further, each of these special devices or systems has required development and supplementary invention at the hands of the technical staff, much as a farmer's crop, the prey of various antagonistic influences, must be cultivated and cared for at the critical stages of its growth.

The development of the repeater also brought to hand means of magnifying sounds which are ordinarily below the level of hearing. The electric stethoscope followed and is proving of great value. The same principle is finding application in the amplifiers of radio receivers; and the Navy, quick to seize upon it, requested the development of a ship-announcing system whereby orders from one or more points are instantly announced over an entire ship.

One of the most picturesque by-product applications

of telephone research is that which revolutionized the old and supposedly well-nigh perfected art of submarine ocean telegraphy. Searching for new magnetic materials that might have application to telephony, engineers of Bell Telephone Laboratories discovered a remarkable alloy to which they gave the name permalloy because of the extreme ease with which it can be magnetized. This material is finding important uses in the telephone plant—loading coils in particular might be mentioned—but we pass at once to its use in the submarine telegraph cable. Here it is applied as a tape wound around and continuously " loading " the copper conductor, thereby reducing attenuation of signals to such a point that a transatlantic permalloy cable handles about as much traffic as five cables of the old style.

Another illustration of what permalloy makes possible is found in the miniature receiver of the audiphone. This device, although so small that its diaphragm is scarcely half an inch in diameter, is just as efficient for the purpose as the standard telephone receiver; and instead of weighing about a pound, is so light that it rests within the ear of the user.

The developments resulting from telephone research cover a most diversified field. Some of them fall naturally in line as logical extensions of the service. Others are obviously and distinctly in the class we have designated as by-products. Separating these two, there is no hard and fast line of demarcation. Occasionally a particular development raises the natural question as to whether it is a by-product or an extension of service. Whichever way the decision goes, machinery is available for putting it to use. By-product developments of Bell Telephone Laboratories, not being made available to the public as a logical extension of telephone service, are made available through manufacture by the Western Electric Company and the commercial distributing and business arrangements of its subsidiary companies,

Electrical Research Products and the Graybar Electric Company.

Regarding the transmission of pictures no question arises as to whether or not it should be classed as a by-product. It constitutes the transmission of a kind of intelligence which in its way is just as useful as a telephone conversation. The same may doubtless in time be said of television, although at present this is in a distinctly experimental stage. The genealogy of both shows a clear descent from telephone investigations. As explained at the time of their initial demonstration, each system employs such telephonic principles as carrier current transmission used extensively in multiplexing our long lines, vacuum tube amplifiers—an outgrowth of the repeater—and schemes for equalizing the picture circuit which have resulted from fundamental studies in telephone transmission.

The value of the research work of the Bell System when considered in relation to the System's primary activity of rendering telephone service is sufficient many times over to justify its cost. Improvements in such departments as lead cable and repeaters, as used on the longer telephone circuits, have enabled the Associated Companies to cut many millions of dollars from what an equivalent telephone plant would have cost had these improvements not been available. As seemingly minor an item as a new contact metal saves three millions a year.

Telephone research is, therefore, a business that yields the telephone-using public generous and frequent dividends in the form of bettered service. And, in the process of advancing the telephone art, more or less unpremeditated benefits are conferred upon other arts and industries.

In a complete appraisal of the value of the applied science program of the Bell System, recognition should be given to such side developments. To state their value in monetary terms would be extremely difficult.

They are great, however, and are destined to increase in value as time passes, for of all growing things the seeds of scientific research are perhaps the most fruitful. The sunlight which stimulates them comes from the broadening horizon of human needs, and the more highly developed our industrial civilization becomes the more widespread is their applicability. For fecundity the principles of science are like the teeth from the fire-breathing dragon of old, but their influence is as constructive as that of the mythical monster and its progeny were supposed to be destructive.

R. W. KING.

Abstracts of Recent Technical Papers from Bell System Sources

The Practical Application of the Fourier Integral,[2] by George A. Campbell. The growing practical importance of transients and other non-periodic phenomena makes it desirable to simplify the application of the Fourier integral in particular problems of this kind and to extend the range of problems which can be solved in closed form by this method. Unless the physicist or technician is in a position to evaluate the definite integrals which occur, by mechanical means, he is usually entirely dependent upon the results obtained by the professional mathematician. To facilitate the use of the known closed form evaluations of Fourier integrals many of them have been compiled and tabulated in Table I. They are presented, however, not as definite integrals but as paired functions, one function being the coefficient for the cisoidal oscillation (or complex exponential) and the other function the reciprocally related coefficient for the unit impulse. This arrangement simplifies the table and promises to be most convenient in practical applications, since it is the coefficients of which immediate use is made, just as in the case of the Fourier series. Applications of the tabulated coefficient pairs to 85 transient problems are given, together with all necessary details, in Table II.

Automatic Machine Gaging,[3] by C. W. Robbins. This paper discusses the advantages to be gained in certain types of large scale production by the substitution of automatic machine gaging for hand testing. For testing carbon protector blocks, a machine has been developed which accepts all blocks in case a certain di-

[2] Bell System Technical Journal, October, 1928.
[3] Bell System Technical Journal, October, 1928.

mension lies between 0.0024" and 0.0032" and rejects those when the dimension is 0.0023" or less or 0.0033" or more. This machine will effect a saving of $8,000 per year over the cost of hand gaging on an output of 4,500,000 blocks. The saving effected by another recently developed machine replacing a manual test is approximately $1,200 a year on a production of 2,500,000 pieces, but a far more important consideration than this money saving is the elimination of an operation so monotonous that it was difficult to keep any operator on it for more than a brief period. The author points out that in some instances automatic machine gaging of the entire product will cost less than a sampling inspection in which there must be included in the direct cost of inspection the cost of some additional supervision and control.

Harmonic Production in Ferromagnetic Materials at Low Frequencies and Low Flux Densities,[4] by Eugene Peterson. When a multi-channel communication circuit includes a non-linear element such as a ferromagnetic core coil, distortion of the wave form impressed upon the circuit is produced. The behavior of magnetic materials to complex waves of magnetizing force is ordinarily a highly involved process, so that a direct correlation between distortion and some of the easily measured constants of materials is a matter of some difficulty. It has been established experimentally, as a confirmation of theoretical speculations, that the third harmonic e.m.f. generated by a sinusoidal wave of magnetizing force may serve as an index of the distortion with a complex wave of magnetizing force. This relation is valid for low flux densities and for frequencies at which the screening effect of eddy currents is not important.

The theoretical deductions are found to be in general agreement with experiment, and are applied to a

[4] Bell System Technical Journal, October, 1928.

number of cases of practical interest. These include the effects of air gaps and dilution, and the choice of core material in third harmonic production by inductance coils and transformers. Finally, the amount of third harmonic current flowing out of long lines is deduced with both lumped and continuous loading.

Influence of Carbon and Silicon Variations in Grey Cast Iron,[5] by D. G. Anderson and G. R. Bessmer. In this short article the author gives the results of a series of tests of grey cast-irons with different carbon and silicon contents. Three series were run in each of which the silicon content was kept constant and the amount of carbon varied. The results indicated that with two percent silicon the carbon content may be reduced without materially increasing the amount of combined carbon. This results in some improvement in the physical properties of the iron.

Strength-Tests of Telephone Materials,[6] by J. R. Townsend. Static tests, such as the ordinary tension or torsion tests, have fallen somewhat into disrepute during the last ten years, the author claims, as the ultimate strengths obtained from them are not always indicative of the forces materials will withstand in actual service. Their place is being taken by repeated-stress tests in which the sample is subjected to conditions more nearly representing those met in ordinary service. In illustration the author mentions several tests of this class being applied in Bell Telephone Laboratories on cable sheath material and springs.

The Reduction of Atmospheric Disturbances,[7] by John R. Carson. In the decade or so during which the problem of eliminating or at least reducing atmospheric

[5] Fuels and Furnaces, Vol. VI, No. 7, pp. 957 and 972, July, 1928.
[6] Instruments, Vol. 1, No. 7, pp. 313–315, July, 1928.
[7] Proceedings of the Institute of Radio Engineers, July, 1928, Vol. 16, No. 7, pp. 966–975.

disturbances has been given serious and systematic study we have learned, more or less definitely, what we can and cannot do in this direction. For example, we know that there are definite limits to what can be accomplished by frequency selection. We know that directional selectivity is of substantial value, particularly when the predominant interference comes from a direction other than that of the desired signal, and we can calculate pretty well the gain to be expected from a given design.

The object of this note is to analyze another arrangement which provides for high-frequency selection plus low-frequency balancing after detection. The broad idea of balancing out the interference is old, but no general analysis of the arrangement seems to have been made. Furthermore the principle of balance has recently acquired fresh interest due to the system disclosed by Armstrong[8] in which high-frequency selectivity and low-frequency balancing are essential features. Armstrong's scheme is treated in more detail in the latter part of this paper.

The conclusions of this study are entirely negative, that is, no appreciable gain is to be expected from balancing arrangements. This is quite in agreement with the conclusion drawn over ten years ago as a result of a rather extended experimental study made in the Bell System. In fact, as more and more schemes are analyzed and tested, and as the essential nature of the problem is more clearly perceived, we are unavoidably forced to the conclusion that static, like the poor, will always be with us.

Thermostat Design for Frequency Standards,[9] by W. A. Marrison. A means for maintaining constant temperature is described in which those temperature variations which are essential for operation of the con-

[8] Proceedings of the Institute of Radio Engineers, Jan., 1928, Vol. 16, No. 1, p. 15.

[9] Proceedings of I. R. E., Vol. 16, No. 7, pp. 976–980, July, 1928.

trolling element are prevented from reaching the controlled chamber by a wall of material especially chosen for the purpose. Such a wall 1 cm. thick, consisting of alternate thin layers of felt and copper, will reduce temperature variations having a period of one minute or less by a factor of 10,000 to 1.

Technical Considerations Involved in the Allocation of Short Waves; Frequencies between 1.5 and 30 Megacycles,[10] by Lloyd Espenschied. This short paper discusses the relation between frequency and distance of transmission for short waves in so far as it affects allocation. A table is given in which the entire short-wave field from 10 to 200 meters is divided into three major bands each containing numerous sub-bands. For each sub-band the number of channels theoretically possible is given and also the number of channels being used at the present time. Factors affecting the separation of channels are also listed.

Effect of Street Railway Mercury Arc Rectifiers on Communication Circuits,[11] by Charles J. Daly. This paper describes the effects experienced on the telephone circuits from two mercury arc rectifier substations recently installed in Bridgeport, Conn., and shows in table form the relative magnitude of the interfering effects between rotating equipment and mercury arc rectifiers as a means of energizing the street railway system. The method and the type of apparatus used to reduce the effects experienced from the rectifiers are also described.

Compressed Powdered Permalloy—Manufacture and Magnetic Properties,[12] by W. J. Shackelton and I. G. Barber. The paper gives a brief description of the

[10] Proceedings of the I. R. E., Vol. 16, No. 6, pp. 773–777, June, 1928.
[11] Journal of the A. I. E. E., Vol. XLVII, No. 7, pp. 503–506, July, 1928.
[12] Journal of the A. I. E. E., Vol. XLII, No. 6, pp. 437–440, June, 1928.

manufacture of magnetic cores of compressed permalloy powder followed by information covering their magnetic properties with particular reference to their use in loading coils. Production of the powder, and its insulation, pressing and annealing, are discussed. Under magnetic properties, permeability, core loss, and modulation are treated. Curves are given illustrating the characteristics of interest in connection with the design and application of loading coils; and comparisons to corresponding characteristics of compressed powdered iron are made throughout.

Thermal Agitation of Electric Charge in Conductors,[13] by H. Nyquist. The electromotive force due to thermal agitation in conductors is calculated by means of principles in thermodynamics and statistical mechanics. The results obtained agree with results obtained experimentally.

Time-Lag in Magnetization,[14] by Richard M. Bozorth. An investigation has been made of the time-lag in magnetization in a permalloy wire to determine whether lag can be satisfactorily accounted for as due to eddy-currents alone or whether permalloy shows a marked magnetic viscosity such as has been observed by Ewing in iron wires. Eddy-current lag has been calculated approximately in a manner which takes into account the changing slope of the magnetization curve. A comparison of the calculated and observed magnetization-*vs.*-time curves indicates that the effect is well accounted for as eddy-current lag alone. The eddy-current lag has also been calculated for an iron ring, for which the time-lag has been reported recently in a number of papers by Lapp. The time-lag which he observed is satisfactorily accounted for as eddy-current lag instead of as magnetic viscosity as he had supposed.

[13] Physical Review, Vol. 32, No. 1, pp. 110–113, July, 1928.
[14] Physical Review, Vol. 32, No. 1, pp. 124–132, July, 1928.

Thermal Agitation of Electricity in Conductors,[15] by J. B. Johnson. Statistical fluctuation of electric charge exists in all conductors, producing random variation of potential between the ends of the conductor. The effect of these fluctuations has been measured by a vacuum tube amplifier and thermocouple, and can be expressed by the formula $\bar{I}^2 = (2kT/\pi)\int_0^\infty R(\omega)\,|Y(\omega)|^2 d\omega$. I is the observed current in the thermocouple, k is Boltzmann's gas constant, T is the absolute temperature of the conductor, $R(\omega)$ is the real component of impedance of the conductor, $Y(\omega)$ is the transfer impedance of the amplifier, and $\omega/2\pi = f$ represents frequency. The value of Boltzmann's constant obtained from the measurements lie near the accepted value of this constant. The technical aspects of the disturbance are discussed. In an amplifier having a range of 5000 cycles and the input resistance R the power equivalent of the effect is $\bar{V}^2/R = 0.8 \times 10^{-16}$ watt, with corresponding power for other ranges of frequency. The least contribution of tube noise is equivalent to that of a resistance $R_e = 1.5 \times 10^5 i_p/\mu$, where i_p is the space current in milliamperes and μ is the effective amplification of the tube.

The Voltage-Current Relation in Central Cathode Photoelectric Cells,[16] by Thornton C. Fry and Herbert E. Ives. This paper presents a theoretical basis for the interpretation of the experimental results described in the paper which follows. It considers a source of photoelectrons located on the inner of two concentric spheres; derives the trajectory of an electron shot off at any angle with any speed; and then makes use of this information to compute the current which would be received by a small collector located anywhere on the outer sphere upon very general assumptions as to the directional distribution and velocity distribution of the photoelectrons. This theoretical study is followed by

[15] Physical Review, Vol. 32, No. 1, pp. 97–109, July, 1928.
[16] Physical Review, Vol. 32, No. 1, pp. 44–56, July, 1928.

graphical presentation of results computed for several typical cases of special interest in connection with the experimental study.

The Distribution in Direction of Photoelectrons from Alkali Metal Surfaces,[17] by Herbert E. Ives, A. R. Olpin and A. L. Johnsrud. An experimental study of the distribution in direction of photoelectrons emitted from alkali metal surfaces irradiated by light incident at various angles and polarized in different planes. The alkali metal surfaces used were of two sorts: (1) liquid alloys of sodium and potassium, (2) thin films of potassium or rubidium on polished platinum. In all cases the alkali metal surface was at the center of a large spherical enclosing anode, provided either with collecting tabs at various angular positions or with an exploring finger. It is found that the emission closely obeys Lambert's law, but that the ellipse by which the emission is represented, in polar co-ordinates, is more elongated normally to the surface for perpendicularly incident light than for obliquely, when the direction of the electric vector is in both cases parallel to the surface, and still more elongated for obliquely incident light with the electric vector in the plane of incidence. The distribution curves are all perfectly symmetrical about the normal to the surface, showing no tendency to follow the direction of the electric vector.

Oscillographic Observations on the Direction of Propagation and Fading of Short Waves,[18] by H. T. Friis. The short-wave transmission path is generally but not always located in the vertical plane through the transmission and receiving points.

Direction finding depends upon determining the direction of the wave at the receiving point; it does not

[17] Physical Review, Vol. 32, No. 1, pp. 57–80, July, 1928.

[18] Proceedings of the Institute of Radio Engineers, May, 1928, Vol. 16, No. 5, pp. 658–665.

give accurate results when the twilight zone is in the way of the wave path.

The angle between the earth and the direction of short-wave propagation varies continuously and the changes in this angle are much larger than the changes in angle of propagation in the horizontal plane.

The observations are consistent with the view that the fading is mainly caused by wave interference.

An Improved Permeameter for Testing Magnet Steel,[19] by B. J. Babbitt. The increasing use of cobalt steel in the manufacture of permanent magnets has created a need for a permeameter that is capable of determining accurately the magnetic properties of such steel in bar form. The common commercial permeameters are not capable of producing the high magnetizing forces required for this purpose. Commercial permeameters are chiefly of two types, the yoke type and the Burrows type. The latter is difficult to operate and requires an experienced operator for a reasonable output; it cannot be adapted to the testing of cobalt steel unless it is practically rebuilt throughout. The yoke type of permeameter may be adapted to the testing of cobalt steel by the use of extensions to the poles so that the distance between them is much less. In this way the greater part of the magnetomotive force is distributed over a short portion of the magnetic circuit and the magnetomotive force per centimeter is correspondingly greater. The permeameter that is described below has been developed by the Magnetic Materials Division at the Hawthorne Works of the Western Electric Company to overcome the chief objections common to present commercial permeameters.

Corrosion of Cable Sheath in Creosoted Wood Conduit,[20] by R. M. Burns and B. A. Freed. This paper

[19] Journal of the Optical Society of America and Review of Scientific Instruments, Vol. 17, No. 1, pp. 47–58, July, 1928.

[20] Journal of the A. I. E. E., Vol. XLVII, No. 8, pp. 576–579, August, 1928.

deals with the identification of a corrosion of lead cable placed in creosoted wood conduit, and with the determination and application of methods of allaying it. The trouble was experienced mainly on the Pacific coast where, although Douglas fir conduit was introduced about 1911, the first case of corrosion which could definitely be ascribed to the creosoted conduit did not occur till 1921.

A search for the cause of the trouble led to making systematic analyses of the air present in the conduit and these analyses revealed the presence of acetic acid in sufficient amount to account for the corrosion in the presence of carbon dioxide which was also shown to be present.

After much experimenting a method was developed to stop the corrosion by pumping ammonia into the ducts. Results have been very satisfactory and seem to indicate that a single treatment is sufficient.

Contemporary Advances in Physics—XVI Classical Theory of Light, Part II,[21] by Karl K. Darrow. This article is chiefly an account of the behavior of diffraction gratings and of the simpler forms of interference apparatus, written for the three purposes of showing the quality of the experimental evidence on which the wave-picture of light is chiefly founded, of explaining the principal methods of measuring wavelength, and of preparing the ground for a subsequent exposition of the analysis of crystal structure by means of X-ray diffraction patterns.

Small Samples—New Experimental Results,[22] by W. A. Shewhart and F. W. Winters. This article reviews briefly the Theory of Errors of Averages, paying particular attention to some of the most recent work in connection with small samples. New empirical results

[21] Bell System Technical Journal, October, 1928.

[22] Journal of American Statistical Association, New Series, No. 162 (Vol. XXIII), pp. 144–153, June, 1928.

are presented showing the advantage that arises from the use of the latest error theory and pointing out the effect of the limitations imposed upon it. The information contained in this paper indicates that further theoretical studies are necessary in order that the application of small sample theory may give more accurate solutions to the problems that arise in practice.

Notes on Recent Occurrences

SCOPE OF TRANSATLANTIC TELEPHONE SERVICE FURTHER EXTENDED

DURING the past summer the scope of the transatlantic telephone service has been further extended to a number of important points on the Continent of Europe and in Mexico. Since June 4th the hours of service have been from 6:30 A.M. to 10 P.M. Eastern Standard Time.

DENMARK

Transatlantic telephone service between America and Copenhagen, the capital of Denmark, through London was opened on June 29th. Copenhagen, with a population estimated at 775,000 has a total of approximately 126,000 telephones.

Denmark was the seventh European country to be connected with America by telephone. The cost of a call between New York and Copenhagen is $51.75 for the first three minutes and $17.25 for each additional minute.

SWEDEN

The transatlantic telephone service was extended to Malmo, Sweden, on July 1st. The service had been available for some time to Stockholm and Gothenburg.

MEXICO–EUROPE

On July 1st, the facilities of the transatlantic telephone circuit were made available to afford communication between the principal cities of Mexico and the European points accessible to telephone communication with the United States. The new service made it

possible to telephone to Europe from Mexico City, Puebla, Tampico, Victoria, San Luis Potosi, Saltillo, Monterrey and Nuevo Laredo.

On July 27th, Guadalajara, the second largest city in Mexico, was connected with the international circuit affording communication with all the Bell System telephones in the United States and Canada. Transatlantic telephone service was extended to Guadalajara on September 1st.

Voices bound for Europe from Mexico pass northward over long distance lines of the Mexican Telephone and Telegraph Company, a subsidiary of the International Telephone and Telegraph Corporation, to the United States border. From there long distance lines of the Bell System carry them to New York, where the transatlantic radiophone system picks them up and speeds them across the ocean.

Norway

Another language joined the family group on the transatlantic circuit on July 6th when the Norwegian tongue was spoken back and forth on a number of conversations between New York and Washington and Oslo, the capital of Norway.

The first of four official calls opening telephone service to Oslo was between Director General Nikelson of the Norwegian Telegraph and Telephones and T. G. Miller, General Manager of Long Lines Department, American Telephone and Telegraph Company. Minister of Commerce Oftedale then spoke with Hans Fay, Norwegian Consul General in New York.

Two calls to Washington were then completed, American Minister L. S. Swenson, in Oslo, talking with Secretary of State Kellogg and Assistant Secretary Castle. Miss Danielsen, Secretary to Halvard Bachke, Norwegian Minister to the United States, was the first woman to talk with Norway, carrying on animated con-

versation with Director General Nikelsen. Several commercial calls followed, among them being a call of greeting to the Bank of Norway from the Federal Reserve Bank of New York, Acting Governor J. Herbert Case speaking to Mr. Thorkildsen, and an interview with Consul General Fay, secured by Editor Bjorn Thommesen of one of the leading Oslo newspapers, The Tidens Tegn.

The rate for a call from New York to Oslo is $52.50 for the first three minutes and $17.50 for each additional minute.

The city of Oslo, with a population of 250,000, has a remarkably high development of 43,000 telephones or over 17 per 100 population. Its distance from London by telephone line is approximately 1,400 miles, the route passing across Holland, Germany and Sweden.

Switzerland

On July 18th still another country was brought within the range of transatlantic telephone service when connections for subscribers on this Continent were extended to all of Switzerland. Swiss cities, including Geneva, mother city of the Red Cross and of the League of Nations, are connected via Paris to London and the transatlantic radio link by means of an 800 mile 4 wire telephone circuit newly established.

The rate for a call from New York to any point in Switzerland is $49.50 for the first three minutes and $16.50 for each additional minute.

Switzerland has a population of nearly four million people and a telephone development of 225,000 instruments. American tourists are expected to enjoy particularly this latest extension of the transatlantic telephone service which includes many popular vacation resorts such as St. Moritz, Zermatt, Montreux, Lugano, Lucerne and Interlaken, as well as the Swiss capital, Berne, and prominent commercial centers such as Zurich.

On the day when telephone service between North America and Switzerland was opened, the American Red Cross from Washington called the International Headquarters in Geneva to extend vocal felicitations upon the establishment of the telephone connection and to honor the centennial year of the birth in Geneva, Switzerland, of Henri Dunant, founder of the Red Cross. John Barton Payne, executive head of the American Red Cross, spoke on this side of the Atlantic and the response was made by Bernard Bouvier, Vice-President of the International Red Cross.

Further exchange of courtesies took place between Colonel Scheurer, Chief of the Swiss Military Department, and Paul Dinichert, Swiss Secretary of State, and Marc Peter, Swiss Minister in Washington. The first call from Switzerland to New York City was made by Doctor Reinhold Furrer, Director General of the Swiss Postal and Telephone Systems, calling Victor Nef, Swiss Consul General in New York.

The Netherlands

A further extension of transatlantic service took place on July 20th to all points in the Netherlands, thus making available service from many Dutch towns of tourist interest for American travellers anxious to keep in close touch with their offices and homes. The transatlantic service was previously available to Amsterdam, Rotterdam and The Hague.

Belgium

On October 1st the scope of the transatlantic service was further extended to include the whole of Belgium. This makes possible telephone communication between America and many Belgian points of interest to tourists, including Bruges, Ghent, Ostend, Waterloo, Liege and Louvain. Previously the only Belgian

points reached by the transatlantic telephone service were Brussels and Antwerp.

Award of John Scott Medal

The Board of City Trusts of Philadelphia, at their meeting in July, 1928, awarded to Dr. H. D. Arnold, Director of Research of the Bell Telephone Laboratories, the John Scott Medal for the "development of the 3-electrode high vacuum tube." The medal, the certificate and an accompanying honorarium were founded in 1816 by John Scott of Edinburgh.

In 1912, Dr. Arnold's attention was called to the "audion" of Dr. Lee DeForest, one of the most interesting and important inventions in modern electrical art. Although at that time, a very crude instrument, incapable of being used as an amplifier of voice currents in long distance telephony, Dr. Arnold recognized the possibilities inherent in this device. He undertook the development which, starting on the basis of the "audion," resulted in the production of the modern 3-electrode high vacuum thermionic tube. This tube is adaptable to a wide range of purposes and was specifically developed by him for commercial use in long distance wire and radio communication.

Presentation of the medal will be made at a meeting of the Franklin Institute at Philadelphia, December 19, 1928.

Recipients of the John Scott Medal have been inventors of outstanding achievement. Messrs. W. G. Housekeeper, G. W. Elmen, and H. E. Ives, all of the Bell Telephone Laboratories, have previously been awarded the medal.

MR. THAYER ENDS 50 YEARS SERVICE

AT a meeting of the directors of the American Telephone and Telegraph Company held in Boston on August 15, H. B. Thayer's resignation as Chairman and as a director of the Company was accepted.

This action of the Board was embodied in the following resolution:

" After nearly half a century of continuous service in the Bell System, during which he has served as President of the Western Electric Company and successively as Vice-President, President, and Chairman of the American Telephone and Telegraph Company, Mr. Harry B. Thayer has asked to be retired on his seventieth birthday, August 17, 1928.

" *Therefore, be it resolved,* that Mr. Thayer's resignation as Chairman and as a member of this Board be accepted in accordance with his desire and with the best wishes of his fellow-directors for his future happiness; and,

" *Be it further resolved,* that the directors hereby record their high appreciation of Mr. Thayer's long devotion to the interests of the Bell System and of his invaluable services in its development and success."

The directors voted an amendment to the by-laws discontinuing the office of Chairman.

When the meeting was over President Walter S. Gifford made a statement, which will be of particular interest to Bell System people.

" After nearly fifty years of continuous service in the Bell System, Mr. H. B. Thayer, Chairman of the American Telephone and Telegraph Company, has retired.

" When Mr. Thayer went to work for the Western Electric Company in 1881, soon after his graduation from Dartmouth College, that company was doing an annual business of about three-quarters of a million dollars. He became President of the Western Electric Company in 1908. When he left to become President of the American Telephone and Telegraph Company the annual business of the Western Electric Company had grown to about one hundred and fifty million dollars.

" When Mr. Thayer resigned as President of the

American Telephone and Telegraph Company over three years ago to become Chairman it was with the idea of gradually relinquishing his responsibilities to the interests he had served so faithfully and long. Now he feels he has earned his freedom from these business cares.

"During Mr. Thayer's connection with the Bell System, the investment which was about twenty-five millions at the time he went to work in the manufacturing company has increased to over three and a half billions.

"Mr. Thayer has always been acquiring friends among the younger men, so that the best wishes of thousands of his present associates in the American Telephone and Telegraph Company and its affiliated organizations are extended to him now and will be his in the years which are to come."

TELEGRAPH COMPANIES TO USE SOME BELL SYSTEM LINES AND APPARATUS

SIMULTANEOUS transmission of telephone and telegraph messages over the same wires is one of the improvements that will be effected on a nation-wide scale as a result of far-reaching arrangements recently consummated between the American Telephone and Telegraph Company and two telegraph companies: the Western Union Telegraph Company and the Postal Telegraph and Cable Corporation. A series of non-exclusive contracts entered into with each of the telegraph companies makes provision for furthering the development of electrical communications along lines made possible by the latest devices and methods developed through the work of the Bell System research experts. By these arrangements the users of electrical communications will receive the benefit of many of the advantages that would follow the consolidation of all

electrical communication facilities, but at the same time the telephone and telegraph companies will maintain complete independence of each other.

One of the new contracts makes the long distance telephone lines of the American Telephone and Telegraph Company available for the transmission of telegraph messages handled by these two telegraph companies.

Further utilization of telegraph lines will be made possible under another of the contracts which provides that the Western Union Telegraph Company and the Postal Telegraph and Cable Corporation may lease apparatus developed in the Bell Telephone Laboratories, the research organization maintained by the American Telephone and Telegraph Company, by which a single pair of telegraph wires may be made, under certain conditions, to serve as several telegraph channels.

Still another of this series of contracts makes available for the customers of these two telegraph companies the use of the telephone company's telephoto system for the transmission of facsimile messages between cities in which stations for the transmission of pictures by wire are maintained by the telephone company. At present telephotograph service is available between New York, Boston, Atlanta, Cleveland, Chicago, St. Louis, San Francisco and Los Angeles.

In entering into this series of non-exclusive contracts, the Western Union Telegraph Company and the Postal Telegraph and Cable Corporation have taken advantage of the offer of the American Telephone and Telegraph Company to make available to telegraph companies certain developments which have been worked out by telephone engineers that are of particular practical value to the telegraph business. In addition to the devices already mentioned for increasing the message capacity of telegraph lines and for the simultaneous transmission of telegraph messages over telephone lines without interfering with the use of the

latter for telephone purposes, the Bell Telephone Laboratories have worked out improvements which have been applied to submarine telegraph cables, as a result of which it has been possible to obtain a large increase in the capacity of the ocean cables for handling telegraph traffic.

SCULPTURED GROUP PLACED IN LOBBY

AN allegorical group of sculpture in bronze and marble has been put up in the main lobby of the Telephone and Telegraph Building, 195 Broadway, New York City, in a place which was designed for its reception when the building was erected. This group, which is the work of Chester Beach, the noted sculptor, expresses the idea of the words inscribed on the base: "Service to the Nation in Peace and War." The heroic central figure in bronze represents Service, calling and sending forth the power of the nation. Conceived as a great dynamic force, Service stands before the flag, conscious of the vital epic romance, past and future, that is carried through the air. Behind the head of this figure are lines of uncoiling wire, and at the base, partly covered by the flag, a wreathed helmet of the World War bespeaks the thought of those who gave all in the service of their country.

Above the bronze, in marble blending with the walls, are figures representing the messages of peace and war as they speed along the wires. They encircle a sculptured outline of the United States, on which East, West, North and South are interlinked with lines of communication.

Chester Beach, the sculptor, studied in Paris and Rome and then settled in New York. He is a National Academician, a member of the National Institute of Arts and Letters, and was President of the National Sculpture Society for the year 1927–1928. He is the sculptor of many notable busts, four of which are in the

Hall of Fame; and his graceful garden sculpture includes the well-known "Glint of the Sea," "The Surf," and "The Sea Horse." Among his noted sculptures are "Beyond" in the Spreckels Museum at San Francisco and "Sacred Fire" in the Academy of Arts and Letters in New York. The most recent work of his to be unveiled is the great Fountain of the Waters, in front of the Museum in the Fine Arts Gardens, in Cleveland.

Organization Changes

NEW ENGLAND TELEPHONE AND TELEGRAPH COMPANY

Robert J. Estabrook elected Vice-President and General Manager.

Entered employ of the Bell System as Service Inspector, Central District and Pittsburgh Telephone Company, Pittsburgh, Pa., August, 1902; Chief Service Inspector, January, 1904; Division Operator, July, 1905; Superintendent of Traffic, Northwestern Telephone Exchange Company, Minneapolis, Minn., May, 1906; Toll Fundamental Plan Engineering, American Telephone and Telegraph Company, New York City, August, 1907; Engineer, June, 1920; General Traffic Manager, New England Telephone and Telegraph Company, Boston, Mass., August, 1923; General Manager, December, 1925; Vice-President and General Manager, July, 1928.

NORTHWESTERN BELL TELEPHONE COMPANY

Title of A. A. Lowman changed to Vice-President (in Charge of operations).

Entered employ of the Bell System as Lineman, Iowa Telephone Company, 1894; Switchboard Installer, Oskaloosa, 1898; District Manager, Shenandoah, January, 1900; Wire Chief, Nebraska Telephone Company, Council Bluffs, January, 1901; Omaha, May, 1906; Plant Superintendent, 1909; Division Plant Superintendent, January, 1911; Division Plant Superintendent, Northwestern Telephone Exchange Company, Minneapolis, Minn., March, 1913; General Plant Superintendent, Northwestern Group, Omaha, June, 1914; Vice-President and General Manager, Northwestern Bell Telephone Company, May 1919; Vice-President, July, 1928.

Iowa Area

H. G. Conger appointed General Manager.

Entered employ of the Bell System as District Manager, Iowa Telephone Company, Iowa Falls, July, 1910; Commercial Manager, Des Moines, July, 1911; Assistant Commercial Manager, July, 1913; Division Commercial Superintendent, September, 1913, with additional title of Assistant Secretary, September, 1914; Division Manager and Assistant Secretary, Northwestern Bell Telephone Company, May, 1922; General Manager and Assistant Secretary, Iowa Area, July, 1928.

F. W. Rulison appointed Chief Engineer.

Entered employ of the Bell System as Lineman, Central Union Telephone Company, Bloomington, Ill., March, 1902; Lineman, Iowa Telephone Company, Burlington, April, 1903; Des Moines, July, 1903; P. B. X. Man, January, 1909; Construction Engineer, September, 1909; Division Engineer, July 1911; Division Superintendent of Plant, November, 1919; Division Superintendent of Plant, Northwestern Bell Telephone Company, January, 1921; Engineer of Outside Plant, Omaha, November, 1925; Chief Engineer, Iowa Area, Des Moines, July, 1928.

E. C. Hartley appointed Commercial Manager.

Entered employ of the Bell System for the summers of 1905–06–07–08–09 as Lineman, Iowa Telephone Company, at Sioux City in 1905 and 1906, and at Ida Grove 1907–08–09; Special Agent, Des Moines, July, 1910; Division Commercial Engineer, August, 1910; Chief Clerk, Iowa, Nebraska and Northwest Telephone Company, Omaha, August, 1911; Commercial Agent, September, 1913; Commercial Engineer, November, 1916; General Commercial Engineer, Northwestern Bell Tele-

phone Company, May, 1922; Commercial Manager and Assistant Secretary, Iowa Area, Des Moines, July, 1928.

E. J. McGrath appointed Plant Manager.

Entered employ of the Bell System as Wire Chief, Northwestern Telephone Exchange Company, St. Paul, Minn., May, 1908; Duluth, February, 1915; District Wire Chief, Nebraska Telephone Company, Omaha, January, 1916; Division Maintenance Supervisor, Northwestern Telephone Exchange Company, Minneapolis, May, 1917; Division Superintendent of Plant, Northwestern Bell Telephone Company, Des Moines, November, 1925; Plant Manager, Iowa Area, July, 1928.

George Drew appointed Traffic Manager.

Entered employ of the Bell System as Solicitor, Nebraska Telephone Company, Omaha, April, 1906; District Manager, Seward, October, 1906; Freemont, March, 1909; District Traffic Chief, Omaha, August, 1909; District Traffic Chief, Iowa Telephone Company, Des Moines, February, 1913; Division Superintendent of Traffic, October, 1920; Division Superintendent of Traffic, Northwestern Bell Telephone Company, January, 1921; Traffic Manager, Iowa Area, July, 1928.

Minnesota Area

Frank Bracelin appointed General Manager.

Entered employ of the Bell System as Local Repairman, Michigan Telephone Company, St. Joseph, Mich., June, 1898; Lineman, Niles, August, 1899; Division Inspector. Kalamazoo, October, 1901; Toll Line Repairman, Niles, May, 1902; Manager, Northwestern Telephone Exchange Company, Anoka, Minn., February, 1905; Grand Forks, N. D., December, 1906; District

Commercial Manager, Crookston, Minn., April, 1907; Fargo, N. D., May, 1912; Division Commercial Superintendent and Assistant Secretary, Minneapolis, May, 1919; Division Commercial Superintendent and Assistant Secretary, Northwestern Bell Telephone Company, April, 1921; Division Manager and Assistant Secretary, May, 1922; General Commercial Superintendent, Omaha, January, 1925; General Manager, Minnesota Area, Minneapolis, July, 1928.

H. J. Pierce appointed Chief Engineer.

Entered employ of the Bell System as Equipment Engineer, Northwestern Telephone Exchange Company, Minneapolis, Minn., November, 1909; Division Equipment Engineer, April, 1911; Assistant Equipment Engineer, Iowa and Nebraska Northwestern Telephone Company, Omaha, July, 1919; Equipment Engineer, March, 1920; Acting Equipment and Building Engineer, Northwestern Bell Telephone Company, May, 1923; Equipment and Building Engineer, December, 1923; Engineer of Building and Equipment, December, 1925; Chief Engineer, Minnesota Area, Minneapolis, July, 1928.

J. P. Mason appointed Commercial Manager.

Entered employ of the Bell System as Collector, Iowa Telephone Company, Burlington, Ia., August, 1901; Switchboard Inspector, Davenport, November, 1902; Traveling Inspector, March, 1903; Manager, Ft. Madison, March, 1904; Keokuk, January, 1906; Service Inspector, Des Moines, March, 1907; Manager, Clinton, February, 1908; Chief Clerk, Des Moines, October, 1908; Division Traffic Superintendent, July, 1909; Toll Traffic Engineer, Nebraska Telephone Company, Omaha, November, 1912; District Traffic Chief, Iowa Telephone Company, Davenport, December, 1913; Des Moines, October, 1920; District Superintendent of

Traffic, Northwestern Bell Telephone Company, Omaha, November, 1924; Minneapolis, November, 1925; Commercial Manager and Assistant Secretary, Minnesota Area, July, 1928.

H. P. Storkerson appointed Plant Manager.

Entered employ of the Bell System as Collector, Wisconsin Telephone Company, La Crosse, Wis., April, 1898; Installer, January, 1900; Inspector, January, 1901; Switchboardman, January, 1902; Installer, Northwestern Telephone Exchange Company, Minneapolis, August, 1902; Installer, Michigan State Telephone Company, Detroit, April, 1905; State Equipment Foreman, September, 1906; District Manager, Kalamazoo, November, 1908; Equipment Inspector, Detroit, August, 1910; Switchboardman, Northwestern Telephone Exchange Company, Minneapolis, November, 1910; St. Paul, January, 1911; Inspector, September, 1911; District Inspector, March, 1912; District Wire Chief, April, 1913; District Plant Chief, Grand Forks, N. D., September, 1913; St. Paul, April, 1914; Minneapolis, May, 1918; Division Superintendent of Plant, May, 1919; Plant Manager, Minnesota Area, July, 1928.

O. A. Scattergood appointed Traffic Manager.

Entered employ of the Bell System as Clerk, Nebraska Telephone Company, Omaha, Neb., May, 1916; on furlough for military service, July, 1918 to January, 1919; Head Payroll Clerk, November, 1919; Payroll Supervisor, December, 1920; resigned in 1921; re-engaged as Traffic Student, Northwestern Bell Telephone Company, Minneapolis, May, 1921; Traffic Chief, November, 1921; District Traffic Supervisor, January, 1922; District Traffic Chief, Duluth, September, 1923; General Traffic Employment Supervisor, Omaha, January, 1928; General Employment Supervisor, May,

1928; Traffic Manager, Minnesota Area, Minneapolis, July, 1928.

Nebraska—South Dakota Area

W. F. Cozad appointed General Manager.

Entered employ of the Bell System as Inspector, Colorado Telephone Company, Trinidad, Colo., November, 1899; Agent, La Junta, February, 1901; Assistant Manager, Denver, October, 1901; Manager, March, 1903; Superintendent of Traffic, January, 1905; Traffic Engineer, January, 1907; Superintendent of Traffic, January, 1911; Superintendent of Traffic, Mountain States Telephone & Telegraph Company, July, 1911; General Traffic Superintendent, August, 1911; Assistant to Vice-President, T. S. Telephone Company, March, 1920; General Traffic Superintendent, Mountain States Telephone & Telegraph Company, September, 1920; General Superintendent of Traffic, Northwestern Group, Omaha, December, 1920; General Manager, Northwestern Bell Telephone Company, Nebraska-South Dakota Area, July, 1928.

A. L. Turner appointed Chief Engineer.

Entered employ of the Bell System as Lineman, Northwestern Telephone Exchange Company, Owatonna, Minn., May, 1903; Inspector, June, 1904; Wire Chief, November, 1905; District Plant Chief, September, 1909; on furlough for military service, January, 1919 to March, 1919; District Plant Chief, Nebraska Telephone Company, Deadwood, March, 1919; District Wire Chief, October, 1919; Employment Supervisor, Omaha, April, 1920; Construction Engineer, October, 1920; Exchange Facilities Engineer, Northwestern Bell Telephone Company, September, 1921; Engineer, January, 1922; Engineer of Transmission, Protection and Foreign Wire Relations, November, 1925; Engineer of

Plant Extension, January, 1928; Chief Engineer, Nebraska-South Dakota Area, July, 1928.

W. R. Johnson appointed Commercial Manager.

Entered employ of the Bell System as Division Special Agent, Nebraska Telephone Company, Omaha, March, 1916; Local Commercial Manager, Freemont, June, 1916; Division Special Agent, Omaha, September, 1916; Division Special Agent, Northwestern Telephone Exchange Company, Minneapolis, June, 1917; Division Supervisor of Methods, September, 1917; Chief Commercial Agent, February, 1918; Special Agent, September, 1918; Supervisor of Methods, December, 1918; District Commercial Manager, Fargo, May, 1919; Supervisor of Methods, Northwestern Group, Omaha, October, 1920; General Commercial Supervisor, May, 1922; General Commercial Supervisor, Dakota Central Telephone Company, July, 1923; Division Manager, Northwestern Bell Telephone Company, February, 1925; Commercial Manager, Nebraska-South Dakota Area, July, 1928.

A. W. Devereaux appointed Plant Manager.

Entered employ of the Bell System as lineman, Nebraska Telephone Company, Freemont, Neb., July, 1905; Lincoln, April, 1906; Foreman, March, 1908; Assistant District Foreman, Omaha, July, 1911; District Construction Foreman, April, 1912; District Construction Foreman, Iowa Telephone Company, Des Moines, April, 1913; District Plant Chief, May, 1914; Division Construction Superintendent, Northwestern Bell Telephone Company, February, 1921; General Construction Supervisor, January, 1922; Supervisor of Outside Plant, January, 1925; Division Superintendent of Plant, February, 1925; Plant Manager, Omaha, Nebraska-South Dakota Area, July, 1928.

Paul Bunce appointed Traffic Manager.

Entered employ of the Bell System as Draftsman, Northwestern Telephone Exchange Company, Minneapolis, Minn., June, 1905; resigned September, 1905; reengaged as designer, Fargo, N. D., April, 1906; Traffic Chief, November, 1909; District Traffic Chief, January, 1916; on furlough for military service, September, 1917 to June, 1919; Division Superintendent of Traffic, Northwestern Bell Telephone Company, January, 1921; Omaha, November, 1925; Traffic Manager, Nebraska-South Dakota Area, July, 1928.

North Dakota Area

L. D. Richardson appointed General Manager.

Entered employ of the Bell System as Manager, Wisconsin Telephone Company, Janesville, Wis., March, 1887; La Crosse, January, 1891; General Manager, North Dakota I. Telephone Company, Fargo, August, 1906; Division Commercial Superintendent, Northwestern Telephone Exchange Company, November, 1920; Northwestern Bell Telephone Company, February, 1921; Division Manager, May, 1922; General Manager, North Dakota Area, July, 1928.

G. W. Knauer appointed Chief Engineer.

Entered employ of the Bell System as Tester, Cedar Rapids and Marion County Telephone Company, Cedar Rapids, Ia., June, 1909; Tester, Iowa Telephone Company, November, 1909; Switchboardman, May, 1910; Tester, November, 1910; Assistant Wire Chief, July, 1911; Lineman, July, 1914; Chief Tester, July, 1915; Wire Chief, Red Oak, November, 1915; Tester, Cedar Rapids, September, 1916; Wire Chief, September, 1916; Waterloo, May, 1919; Plant Chief, Northwestern Bell Telephone Company, Cedar Rapids, January, 1922; Division Maintenance Supervisor, Des Moines,

January, 1923; District Plant Chief, Waterloo, February, 1924; Supervisor of Outside Plant, Omaha, March, 1925; Supervisor of Methods and Results, March, 1926; Chief Engineer, North Dakota Area, Fargo, July, 1928.

A. F. McAdams appointed Commercial Manager.

Entered employ of the Bell System as Solicitor, Nebraska Telephone Company, Omaha, June, 1906; Local Commercial Manager, January, 1910; District Commercial Manager, March, 1913; General Commercial Agent, Northwestern Bell Telephone Company, July, 1924; Assistant Division Manager, Fargo, February, 1925; Commercial Manager and Assistant Secretary, North Dakota Area, July, 1928.

E. I. Hannah appointed Plant Manager.

Entered employ of the Bell System as Student, Iowa Telephone Company, Boone, Ia., May, 1899; general telephone work, January, 1900; Combination Man, Central Iowa, September, 1902; Lineman and Inspector, Nebraska Telephone Company, Omaha, July, 1903; Manager, Iowa Telephone Company, Iowa Falls, January, 1905; Foreman and Wire Chief, Nebraska Telephone Company, Council Bluffs, October, 1906; District Plant Chief, Omaha, August, 1909; Division Plant Superintendent, March, 1913; Division Superintendent of Plant, May, 1918; resigned, January, 1920; re-engaged as Assistant Superintendent of Supplies, Northwestern Group, Omaha, August, 1920; Division Superintendent of Plant, Northwestern Telephone Exchange Company, Fargo, November, 1920; Plant Manager, North Dakota Area, Northwestern Bell Telephone Company, July, 1928.

M. W. Ricker appointed Traffic Manager

Entered employ of the Bell System as Solicitor, Northwestern Telephone Exchange Company, Minnea-

polis, September, 1905; resigned, April, 1907; re-engaged as Commercial Manager, Red Wing, May, 1908; Winona, May, 1909; Red Wing, May, 1910; Division Traffic Inspector, Minneapolis, August, 1911; District Traffic Chief, St. Cloud, September, 1911; Fargo, September, 1917; Traffic Inspector, Minneapolis, June, 1919; Supervisor of Traffic, Iowa Telephone Company, Des Moines, July, 1919; Division Supervisor of Traffic, Northwestern Bell Telephone Company, January, 1921; Division Traffic Supervisor, January, 1922; District Traffic Chief, Waterloo, October, 1922; Division Superintendent of Traffic, Fargo, November, 1925; Traffic Manager, North Dakota Area, July, 1928.

PACIFIC TELEPHONE AND TELEGRAPH COMPANY

N. R. Powley appointed Vice-President.

Entered employ of the American Telephone and Telegraph Company, Boston, Mass., in Statistical Division, July, 1908; New York City, September, 1909; Toll Rate Engineer, Pacific Telephone and Telegraph Company, San Francisco, March, 1912; Rate Engineer, January, 1914; Commercial Superintendent, Southern California Telephone Company, Los Angeles, September, 1919; Vice-President and General Manager, January, 1925; Operating Vice-President, Pacific Telephone and Telegraph Company, San Francisco, June 1, 1928.

F. N. Rush appointed General Manager, Southern California Area.

Entered employ of the Bell System as Traffic Inspector, Pacific Telephone and Telegraph Company, Los Angeles, Cal., June, 1909; District Traffic Chief, September, 1910; Division Traffic Inspector, September, 1911; Division Traffic Agent, May, 1912; Division Traffic Agent, Southern California Telephone Com-

pany, May, 1917; District Traffic Chief, January, 1919; Traffic Superintendent, October, 1919; Superintendent of Traffic, January, 1925; Chief Engineer, January, 1926; Vice-President and General Manager, Pacific Telephone and Telegraph Company, Southern California Area, June, 1928.

H. W. Hitchcock appointed Chief Engineer.

Entered employ of the Bell System as Engineer, American Telephone and Telegraph Company, New York City, June, 1913; Engineer, Pacific Telephone and Telegraph Company, San Francisco, Cal., December, 1921; Transmission and Protection Engineer, Southern California Telephone Company, Los Angeles, February, 1924; Outside Plant and Transmission Engineer, February, 1928; Chief Engineer, June, 1928.

C. T. Blanck appointed General Commercial Manager, Northern California and Nevada Area.

Entered employ of the Bell System doing special work for the Pacific States Telephone and Telegraph Company, Los Angeles, Cal., June, 1902; Installer and Lineman, 1903; Foreman, 1904; Draftsman, April, 1906; Development Work with the Pacific Telephone and Telegraph Company, November, 1907; Field Man, March, 1908; District Engineer, June, 1909; Engineer of Exchange Plant, San Francisco, March, 1911; Engineer of Fundamental Plan Work, January, 1914; Assistant Appraisal Engineer, July, 1914; on furlough for military service, December, 1917 to November, 1919; Special Engineer, November, 1919; Assistant to Vice-President, August, 1926; General Commercial Manager, Northern California and Nevada Area, August, 1928.

G. H. Senger appointed Chief Engineer, Northern California and Nevada Area.

Entered employ of the Bell System as Chief Clerk, Pacific Telephone and Telegraph Company, San Francisco, Cal., July, 1909; Engineer of Toll Plant, July, 1910; Engineer on Fundamental Plant and Estimate, July, 1912; Acting Engineer of Outside Plant, November, 1917; Engineer on Fundamental Plant and Estimate, March, 1919; Engineer of Fundamental Plant, July, 1921; Plant Induction Engineer, January, 1926; Chief Engineer, Northern California and Nevada Area, August, 1928.